Radio, Electronics and Communications

FORMERLY "RADIO & ELECTRICAL REVIEW" — WIDELY KNOWN SINCE 1946 AS "R. & E."

MPL

In This Issue . . .

PUBLISHED MONTHLY IN THE INTERESTS OF THE N.Z. ELECTRONICS INDUSTRY FOR ALL LEVELS, FROM PROFESSIONAL TO AMATEUR.

VOLUME 19 NUMBER 4

JUNE 1, 1964

PRICE 2/6

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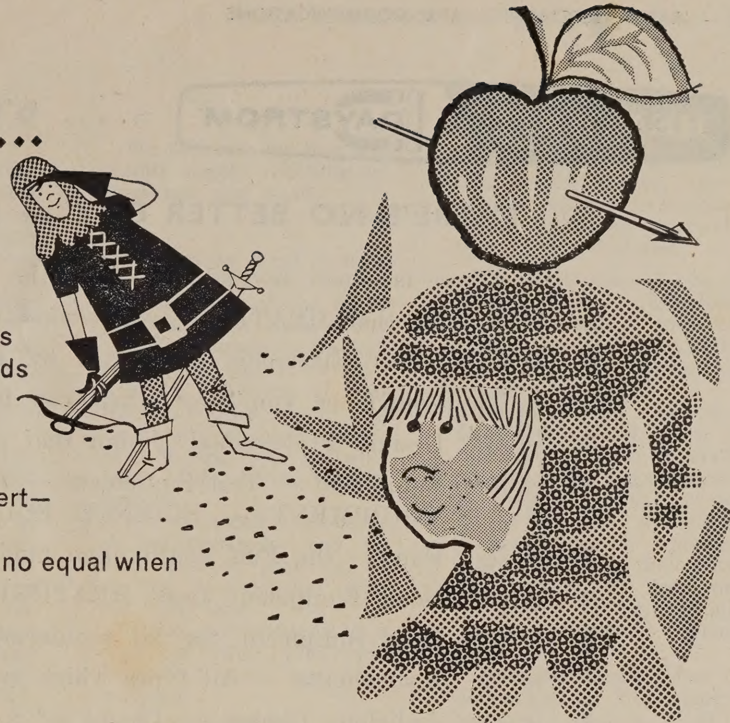

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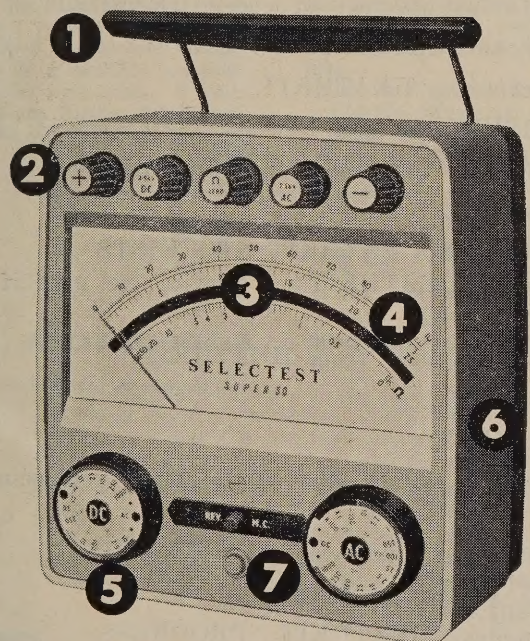

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Letters from Readers . . .

Sir,
I wish to congratulate you on your progressive attitude to make Radio and Electrical Review a better magazine by changing its name to Radio, Electronics and Communications.

As I am very interested in your articles on VHF communications, I am wondering if an article or hints could be given in the construction of two meter transistorised receivers for portable use when one goes tramping in the bush or up mountains? I was thinking in the terms of a variable frequency unit covering the two-metre band. I fully realise this may be a tough one so will not expect quick results.

Yours faithfully,
M. STEELE.

Thank you for your letter and the compliments therein. We suggest that you consider the transistorised two-metre receiver currently described for mobile equipment as a suitable starting point for your trials. If you desire any further details we will do our best to help you.
—Ed.

Sir,
In the Radio and Electrical Review of December last, the "Contrast" series of sound effect recordings was discussed in the Record Review.

I should like to enquire the name of the nearest dealer from whom I could buy the recordings.

Yours faithfully,
W. R. FERGUSSON.

Sir,
Referring to the article appearing in your Record Review column of the 1st December, 1963, edition of Radio and Electrical Review.

I would appreciate any further information you might be able to offer me as regards the acquisition of a copy of the three discs released by "Contrast," Sound Effects AFX1, MFX1, MFX2.

Yours faithfully,
GRAHAM DALY.

Unfortunately we do not know of anyone handling the records locally but include for your assistance the name of the English firm—
Castle & Contrast Records,
174-176 Maybank Rd.,
South Woodford,
London E18, England.

We feel sure the they will readily supply you with information and discs.
—Ed.

Sir,
It gives me great pleasure to congratulate you on the high standard of the Radio and Electrical Review and also the manufacturers who go to some trouble to assist with the publishing of their Radio and TV circuits, as these are of considerable help to me and probably many of your regular readers.

I have cancelled my order at the bookseller and request you to post for 12 months commencing with the May issue.

Could you please send a copy of May 1963 and July 1963, total cost 31/6 enclosed.

Yours faithfully,
J. M. GARDNER.

We are glad you find the magazine of value and hope you will continue to find much to interest you.
—Ed.

V.H.F. AERIALS COURSE

The two-day course on V.H.F. Aerials at Auckland Technical Institute will be held on 12th and 13th August, 1964.

Wednesday, 12th August—Room B. 12.

Introduction: Transmission Lines, theory, types, applications and preferences, losses, matching methods, line sections, discussion.

Demonstration: Types of feeders, line reflections, losses, S.W.R. measurement methods, matching principles, Yagi aerial impedance matching.

Thursday, 13th August—Rooms B. 12 and B. 14.

Electromagnetic radiation, some aspects of propogation at V.H.F., quarterwave, halfwave and directional resonant aerial systems, polar diagrams, directivity, gain, bandwidth, feed impedance, matching, multiple outlets, multiband principles.

Demonstrations: Effect of dimensions on Yagi characteristics, various V.H.F. aerial systems, polar diagram plots. (A 10cm wavelength, model plotting table will be used for the polar diagram plots.)

The course will be essentially practical, but aerial theory notes will be issued. The total fees will be £2/2/- and all intending students should enrol as soon as possible.

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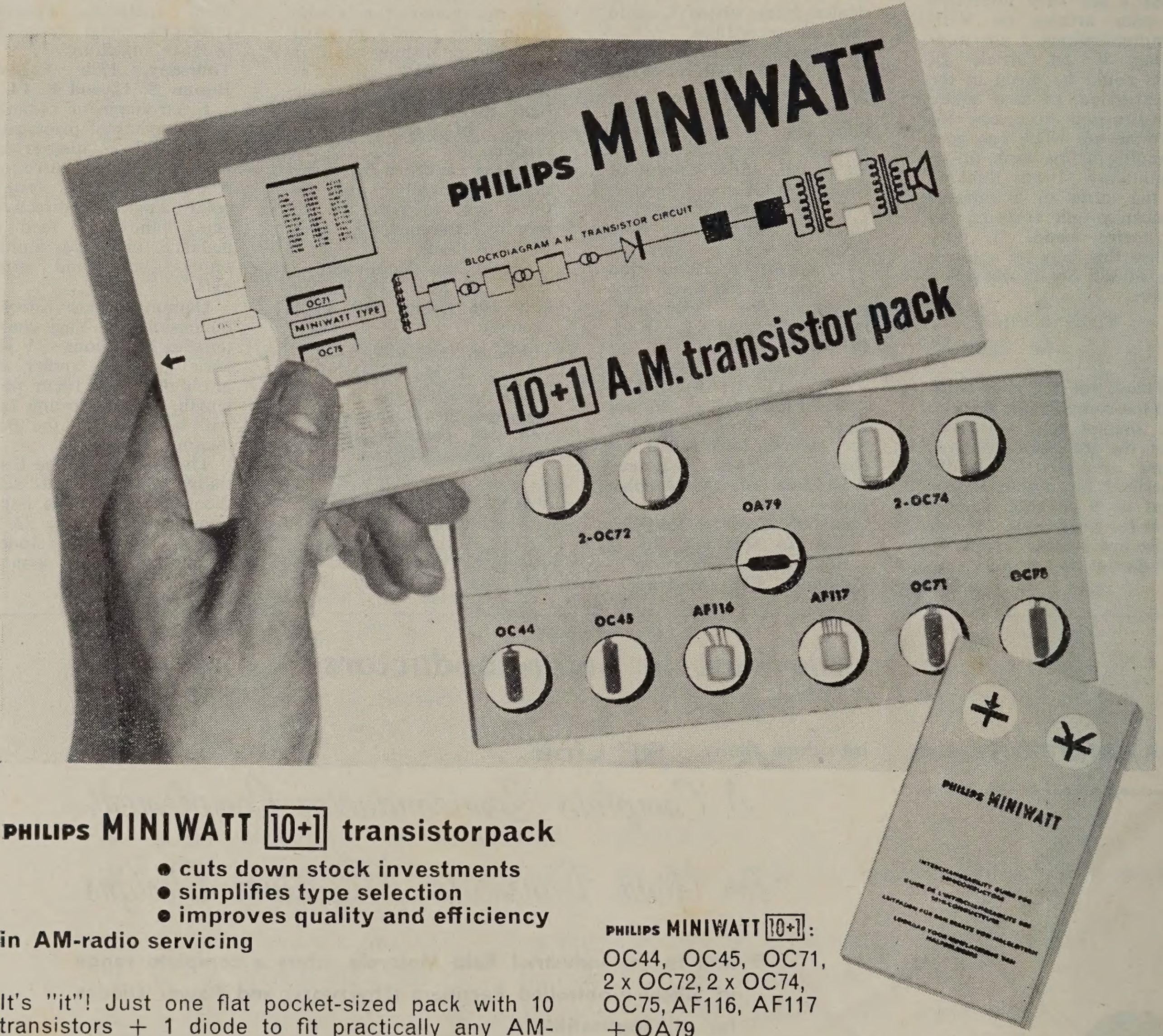

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Vol. 19, No. 4 June 1, 1964

CONTENTS

On Our Cover

This month our cover features a second television coverage map and the article on pages 25-39 discusses the considerations in setting up such a station.

☆

Another Step Forward

Plans are under way at the moment to implement an enquiry card system for our readers. This is designed to cover both advertisers and their products and also all other new products and items of interest in each issue.

In view of the number of times this has been asked for in the past we feel the move should be well received and we hope it will provide a service for readers comparable with the best overseas journals.

FEATURED NEXT MONTH . . .

Introduction to Colour Television
Audio Amplifier Specifications, Capabilities and Measurements. Part II
A Low Distortion Audio Oscillator. Part II
A Vibrator Tester
The S.H.F. Radio Link Comes of Age

Also . .

New Products
Book Reviews
Serviceman's Column
Overseas Notes
Circuit and Service Data

Annual Conference:-

N.Z. ELECTRONICS INSTITUTE (INC.)

The annual conference of the Electronics Institute was held in Wellington over the weekend of 13-14th June. A full programme of visits and social activities was arranged to supplement the symposium (of which a full report appears on this page) and the formal conference business. Although members from the Wellington area made up most of the company there was a good representation from Auckland, Christchurch and other centres.

A highlight of the formal conference session on Saturday was the election of Wing Commander J. W. Todd as a life member. In proposing his election the Wellington branch chairman, Mr. V. M. Stagpoole, said that Mr. Todd had been a tireless worker for the Institute since its inception, and the present conference owed much to his efforts.

The proposal to form a federation of middle group institutes was also discussed at length. It was decided to send a representative to the meetings since such a federation would serve the interests of a large number of the members of the Electronics Institute.

The symposium attracted many visitors from industry, the universities, science and Government, and as can be seen from the report interest and comment on the subject "The Future in Electronics" was lively.

Saturday evening was given over to a social for members and their wives. Varied entertainment was provided, but the opportunity to "talk shop" with members from all over the country was perhaps the most important part of the proceedings.

Sunday saw an improvement in the weather and the visits which had been arranged were well attended. In the morning visits were made to Broadcasting House, where Mr. D. L. Rushworth took members on a tour of the building and facilities, and to the Wellington office of International Computers and Tabulators where the 1301 computer was demonstrated in action.

In the afternoon there was a bus trip to Makara where the Post Office and Broadcasting receiving stations were visited. At Makara Mr. McGechie demonstrated the frequency measuring equipment which keeps track of stations throughout New Zealand. At Quartz Hill Mr. G. C. Andrew, officer in charge, gave an interesting demonstration of the effect of high altitude nuclear explosions on radio wave propagation.

Both visitors and Wellington members voted the conference a rousing success and it is hoped that it will be the forerunner of more national gatherings.

Symposium:-

THE FUTURE IN ELECTRONICS

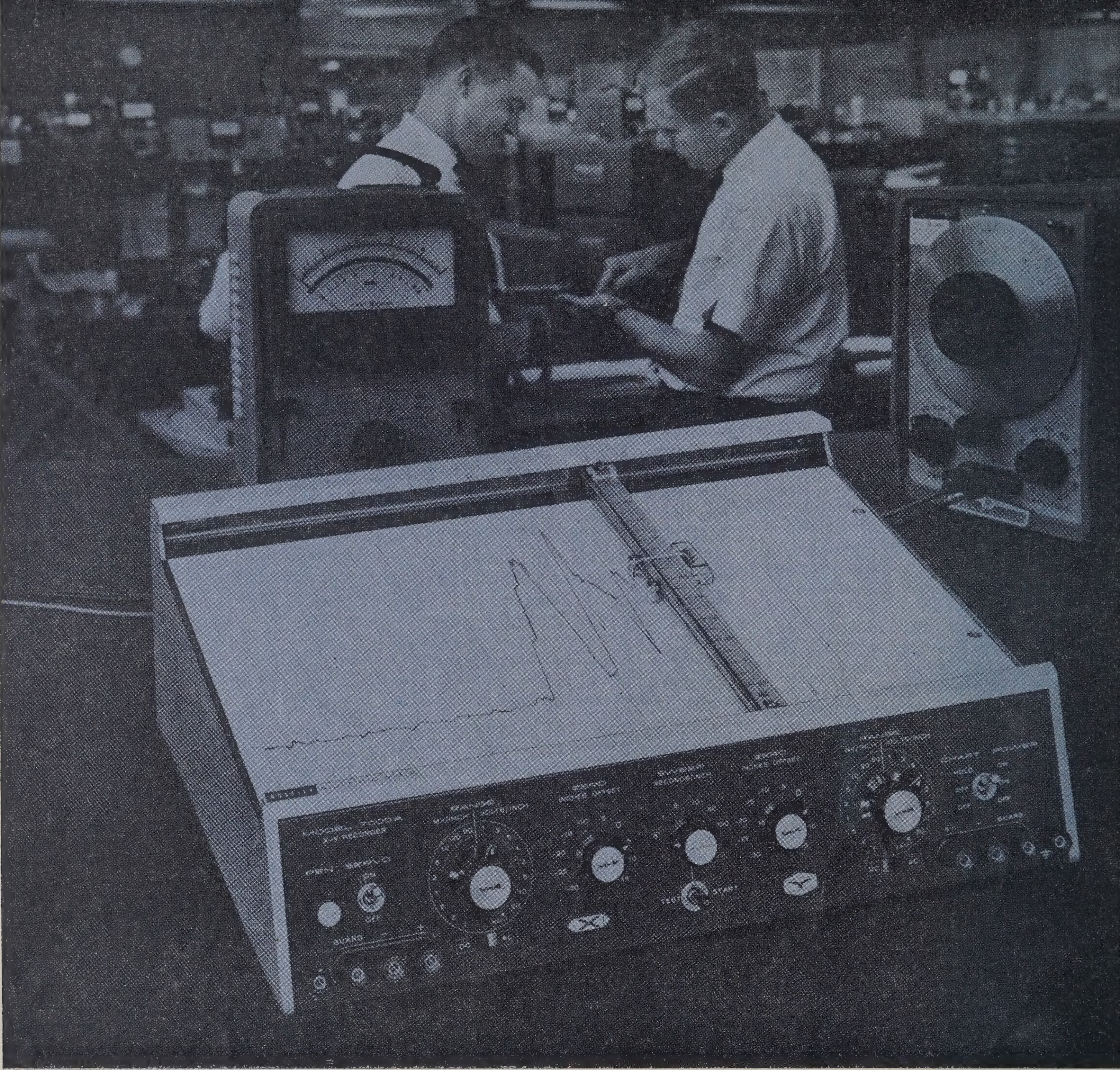
"The physicist will oust the engineer from the spearhead of development in 10 years" was an opinion expressed at the symposium "The Future in Electronics," conducted by the New Zealand Electronics Institute in Wellington on Saturday, 13th June.

Over 50 members and representatives of the technical teaching institutions, Victoria University, Government departments and industry were present. Mr. W. S. Strong, of the Wellington branch of the Institute, was convenor and chairman.

Other points made were: Electronics is a fast expanding field, with the prospect of finding use in the home and industry. There are plenty of opportunities. The low margins paid for skill in New Zealand need up-grading to keep our graduates in New Zealand, and attract prospective engineers and technicians. Versatility and flexibility are necessary in training, to prepare people for advances in the science. There is a considerable shortage of trained electronics men, and this will be a grave problem in the near future.

The first speaker was Mr. E. Carver, manager of the Industrial Electronics Division of Electronic Development and Applications Company. He spoke on the opportunities in electronics in industry. Dividing the application of electronics into five groups, Entertainment (broadcasting and television), Telecommunications, Industrial Electronics, Scientific (instrumentation for research and measurement) and Commerce (computers and electronic office machines) he discussed the future in those fields. Eight factories in New Zealand have produced 120,000 television receivers, worth £15,000,000 ex factory. These have been produced under boom conditions, however, which could be expected to decrease after three or four years, although colour and portable television will prolong the life of production slightly. Production of sound radios would probably continue at 50,000 per year.

Telecommunications represent an expanding field, Mr. Carver continued. Expansion is at the rate of 30 per cent. per annum, compounded, while for industrial electronics expansion is at the rate of 100 per cent. per annum, compounded. This rate seemed likely to continue for several years. Instrumentation is ex-



panding at a lesser rate, and while he had no figures for commercial electronics, there is a phenomenal increase there. All these groups have similar problems—original development and application, technical sales—the most costly factor being the development stage. There is difficulty in costing development, and he stressed the need for physicists, engineers and technicians to have training in basic economics.

"Technical sales offer the greatest opportunities for electronic staff," said Mr. Carver. Such a technician or engineer must have a keen mind, and know his subject in detail, to think how he can improve a factory and sell the improvement to the factory. He emphasised that a different type of man from the development engineer is required for sales.

Service is another important field, and Mr. Carver instanced factories using electronics employing a group of 12 or more maintenance staff for their electronic equipment, under an engineer. He pointed out that where an office has changed to electronic computing, a whole office could be immobilised and be non-productive awaiting repair of a defective computer. In Australia, he said, he had seen a fertiliser factory operated by five men. The factory is completely electronically operated, and an equivalent factory in New Zealand would employ over 100 men. Every day his firm received requests from industry, and opportunities are unlimited.

"Margins for skill must increase drastically," Mr. Carver said in discussing the flow of skilled men going overseas. He considered it ridiculous that with fine universities in New Zealand his own organisation should have to import engineers. He instanced salaries in Australia, where a shopgirl would earn about £450 p.a., a graduate engineer fresh from university £1500 p.a., and a competent engineer in charge of a small group £3000. New Zealand does not have such margins, and without them he did not see a way to stop the losses of trained men to other countries. Facilities for technical education in New Zealand are not yet adequate, probably some millions would need to be spent.

The future lies in home consumption, and also in exporting, mainly to South-East Asia, Mr. Carver concluded. There is an enormous potential market there. New Zealand is already exporting a locally developed hearing aid to many overseas countries, he said.

Mr. C. H. Turner, Chief Telecommunications Engineer in the Forest Service outlined prospects for electronics in Government employment. "Government is the biggest business in the country," he said, and listed the many departments using electronic services, employing over 100 electronic engineers. Technicians beginning in electronics from school could expect about £500 p.a., possibly rising to about £1500 or £1700 in 25-30 years. A graduate engineer, after four years at university, might begin at about £800 or £900, and for the first two years receive practical training. After about 10 years he would earn about £1500, with a maximum of only £2000. A few of the highest engineering positions might reach about £2500.

Mr. Turner mentioned some of the aspects of Government employ, such as being under continuous public scrutiny, leading possibly to rigidity or slowness to change. The Government as an employer tries to be a "good employer," setting concepts of justice to employees.

Dr. B. C. Lee, Superintendent of Technical Education in the Department of Education, reviewed training for electronics. Pointing out that the world today is changing so rapidly, he said that 50 per cent. of the production of a certain chemical firm today was unheard of 10 years ago. Many children at school now are being trained for jobs which do not yet exist, therefore training must be for versatility and flexibility. Moreover we must be prepared to re-train all our lives, to keep up-to-date with changing techniques and new developments. There is a world-wide shortage of technicians, and New Zealand is experiencing this, which is especially typical when emerging from an agricultural, pastoral economy to an industrial one. Here there is specially a shortage in the fields of electronic and chemical engineering.

"No longer will a person be able to enter the world with a set of skills," concluded Dr. Lee, emphasising that education must be a continuous process, and that we are in the midst of a "crescendo of progress."

Mr. C. J. M. Choat, Chairman of the Engineering Associates Registration Board, told the symposium that the question of recognition is urgent. "There is a sense of achievement, of an aim for a goal, among technicians and engineers, which is almost worth more than money to some," he said. Men over 60, even one over 70, had applied for registration as Engineering Associates. He condemned the view of registration as being "too hard to get," saying that hard work and sweat were needed to achieve registration and recognition. Standards for professional engineers had been set for some years in New Zealand, and by registration of the "middle group" a standard has now been set for that group. Already 260 New Zealand Certificates in Engineering had been issued, since the first examinations were set in 1955, and it was now becoming recognised by Government and private employers, and the armed services. The first certificates were issued in 1958, and were now about 100 per year, and increasing.

Of 530 applications for registration, 393 had been registered, 87 deferred, and 50 declined. Basic training and experience, which are essential, are relatively easy to assess, Mr. Choat said. The Board had done this by interviews and travel to find out for itself. Responsibility is harder to define, and the Board had given much thought to defining responsibility when registering applicants. Recognition could not be expected overnight, since registration of Engineering Associates had just begun.

Referring to craftsmen, Mr. Choat said that they are regarded

please turn to page 38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PART I OF A NEW CONSTRUCTION PROJECT

A 10 Watt Low Distortion Audio Oscillator

A quick check of commercially available audio oscillators at present on the New Zealand market resulted in the building of the instrument described below. An oscillator covering the ranges 30-300 c/s, 300-3000 c/s and 3000/15,000 c/s giving an output power of about 8 or 10 watts with distortion under 1% was required for testing speaker cabinets after manufacture for resonance peaks. Whilst low distortion was not inherently required for cabinet testing it was felt that low distortion output would be useful for other test purposes. Commercially available instruments were rated at 1 or 2 watts and cost around £200—the main reason being high stability frequency-wise, a lesser point in the work under consideration.

These methods of generating oscillations at audio frequencies (over a variable range) are available:

(i) Resonant LC circuits
(ii) Phase shift circuits
(iii) Bridge type circuits
and (iv) Beat frequency oscillators.

Readers will be familiar with the single valve circuits (ii) in which, usually, three resistors and three capacitors form a 180° phase shift between anode and grid and provide the positive feedback needed for oscillation. Equally familiar will be the LC circuit (i) used more frequently for R.F. generation. The bulk of the inductances needed for LC circuits together with the difficulty of obtaining suitable items ruled out the use of LC circuits in the design under consideration.

Whilst phase shift oscillators are frequently used for fixed audio frequency oscillators they do not lend themselves to variable frequency output. At the best a three gang variable capacitor would be required. In addition, distortion figures are not as good as other forms of oscillators. It is possible to obtain variable frequency over a limited range with the output amplitude varying appreciably by making one only of the reactive elements variable.

Bridge Oscillators

On the other hand, good amplitude stability and excellent waveshape can result from the use of oscillators combining positive and negative feedback. Figure 1 shows a generalised amplifier having some of the output fed back through a bridge circuit. This circuit will allow positive feedback at one particular frequency ("balance" frequency) with negative feedback at all other frequencies. Two forms of bridge networks are usually used for audio oscillators—the bridged T and Wien Bridge. Both these circuits require either a ganged variable capacitor or ganged variable resistors for satisfactory operation over, say, a 10:1 frequency range. For many years the Wien Bridge circuit was very popular both with experimenters and manufacturers and a basic circuit is shown in Figure 3. In all bridge oscillators both positive and negative feedback are applied and application of the negative feedback is done in such a manner that amplitude control is possible. In Figure 3, for instance, R3 is a small (5 or 10 watt) lamp the non-linear resistive characteristic giving amplitude control automatically as the voltage impressed upon it is increased (or decreased).

Work done by the U.S. National Bureau of Standards on bridged T oscillators has resulted in much improved stability and low distortion figures from such circuits and the oscillator to be described below is based upon the N.B.S. design. As the bridged T circuit is a three terminal network the layout of Figure 1 is achieved by completing the bridge with a resistive network as shown. One further dissimilar point about the bridged T and the Wien circuits—in the Wien bridge oscillator positive feedback is obtained through reactive elements (R and C) and negative feedback through pure resistances (including, as one, the amplitude stabilising lamp). In the bridged T oscillator the positive feedback is

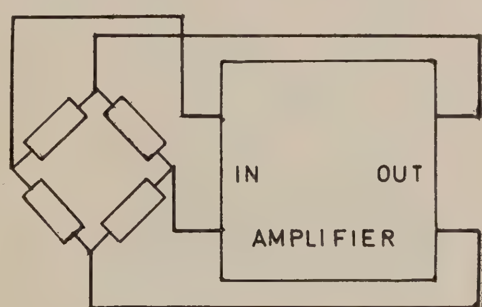


Figure 1 (above) Generalised Oscillator in Bridge Form

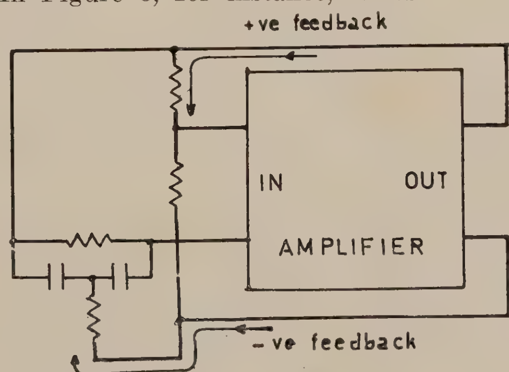


Figure 2 (left) Bridged T Oscillator Showing Feedback Paths

obtained through resistive elements and the negative feedback through the reactive arms.

The application of negative feedback, in addition to providing the necessary conditions for oscillation, provides a reduction in harmonic distortion and it is because of this feature that Bridge type oscillators, whether Wien or T, are to be preferred to other circuits.

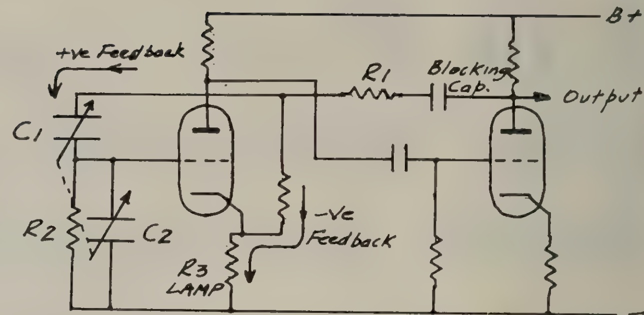


Figure 3—The Basic Circuit of the Wien Bridge Oscillator

Beat Frequency Oscillators

The B.F.O. is a firmly entrenched item where an output over a wide range is required without range switching, say 20 c/s to 20Kc/s in one sweep. Many commercial models in this output range obtain the sweep by "beating" two oscillators at about 100 Kc/s, the fixed one at 100 Kc/s and the variable from approximately 100 Kc/s to 120 Kc/s. Filters are necessary to remove all but the low frequency (0-20 Kc/s) from the heterodyne output and this puts this form of circuit beyond the scope of the average experimenter. Other design features are needed to ensure good output and stability—good frequency stability in each oscillator, good shielding and low distortion in the oscllators. The principal advantage of a B.F.O. is the output over a wide range in one sweep and the mechanical facility, usually provided, of being able to rotate the sweep control from an external drive to tie in with a recorder or oscilloscope sweep.

A Practical Bridge Circuit

In this section we describe a bridged T circuit based on the work done at N.B.S. and the second part will describe the amplifier and output metering circuit.

Figure 4 is the circuit of the oscillator section of our unit. The EF80 (V1) is a pentode voltage amplifier regeneration being provided from the cathode of the EL84 (V2) cathode follower to the cathode of V1 by a path through the lamp stabiliser mentioned above.

Negative feedback, or degeneration, is obtained via the bridged T network from V2 to the grid of V1.

Values of components in the cathode circuits are fairly critical and ± 10% tolerance resistors should be used.

The tuning capacitor is a standard 4 gang Polar but there is no reason why a 2 gang variable should not be used with a slight reduction in range sweep—in fact our prototype had a range sweep of about 26:1 whereas 10:1 is usual. In fact, the limiting of a sweep to 10:1 will improve stability. Even with a trial 20:1 sweep the variation in output level is not worse than ± 10%. The feedback control provides adjustment to compensate for the usual variations in valves and the 40 uF feedback capacitor. Most constructors will probably find the control will need to be fully "towards" V1 cathode. This will also depend upon the lamp chosen. A 5 watt is preferable but a 7 watt lamp may be easier to obtain as this is a standard wattage for many continental pilot lamps used on switchboards.

Next month setting up details will be given in addition to the amplifier design.

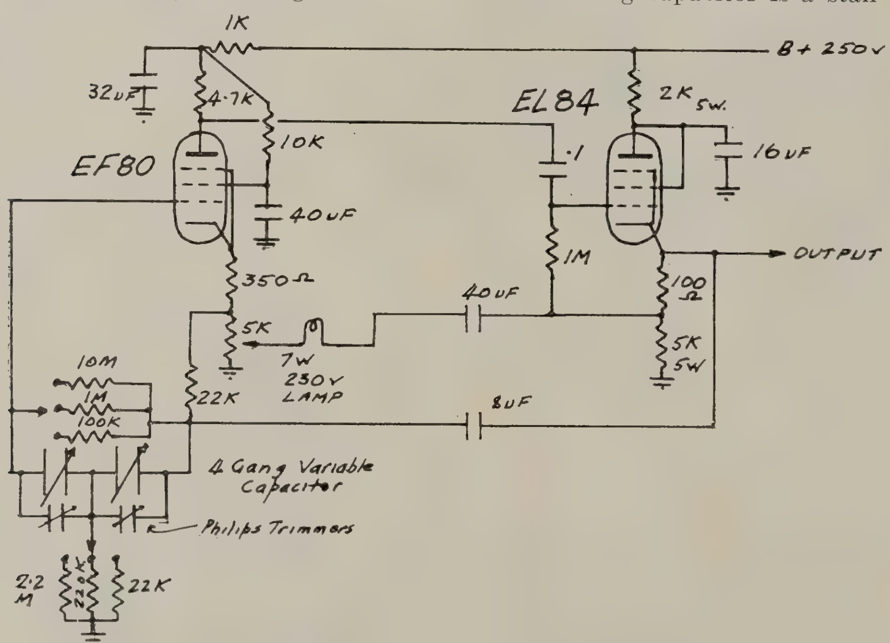


Figure 4—Bridged T Oscillator Circuit

Ranges: (a) 30 c/s - 300 c/s
(b) 300 c/s - 3000 c/s
(c) 3000 c/s - 30 kc/s

These values will depend upon the value of the Gang Capacities

LOOKING AT

AUDIO AMPLIFIER SPECIFICATIONS CAPABILITIES AND MEASUREMENTS

Quite frequently, the Editorial staff of this magazine has been asked to give an opinion as to whether amplifier "A" is better than amplifier "B", or whether amplifier "C", which is alleged to give 6 watts will sound loud enough in a room so big, and so on.

Such questions and problems as these are not unique to this country or to our Editorial staff, judging by the amount of time and print spent discussing the subject overseas, therefore it is undoubtedly fitting that we devote some space also to the subject.

Audio amplifiers, in general, have to satisfy many requirements, but usually when audio signals are passed through an amplifying device it is because they are required to be increased in amplitude so that they can be heard. Whether the signals are picked up from a microphone and amplified directly, or transferred to a record groove or on to magnetic tape, they must be passed through at least one amplifier system, and generally more than one, before arriving at the ultimate destination — the loudspeaker — to be converted back to sound waves. An amplifier, as such, then, is required to increase the amplitude of the original signal in some cases, or to reproduce it under as near identical conditions as possible in others. In all cases, however, what comes out should only be an amplified version of what was originally heard by the pickup device.

For the topic of these articles, we will neglect any effects due to the microphone or loudspeaker or the acoustics of the building if this is present, and concentrate only on the amplifier. This is not to suggest that the microphone or loudspeaker or other reproducing device is perfect—far from it—but we just cannot discuss all sections in the same article.

In practice, amplifiers always modify or alter the signals fed through them, and no matter how little this effect, it is considered under the vague term of "distortion." There are many factors which enter into the reasons for distortion, and in this first article we intend to discuss some of these. In another article we will examine the various technical methods for evaluating and measuring these distortion, products in the light of some of the technical specifications which can be used for direct, fair, and practical comparison of audio amplifiers. Factors such as just how little or how much distortion can be accepted or tolerated, whether intentionally or unintentionally is outside the scope of this article (and could be the cause of a large number of letters to the Editor!).

We have introduced this article at fair length by raising the subject of distortion, because it is the outcome of all other effects which are present, due to shortcomings, in the amplifier system itself.

Let it be said here and now that a perfect amplifier is not obtainable at the present state of the art, but, in general, the better the quality of the amplifier, the less its shortcomings (therefore it usually produces less distortion). Coupled with this fact, is the fairly obvious one, that the better the quality of the amplifier the more costly are its components, and therefore it costs more to purchase and to maintain.

When any sound which we would wish to amplify or reproduce is analysed in detail it can be considered as a combination of two major factors. The first of these is that the signal consists possibly of one, but more usually many different frequencies present together. Some of these frequencies may even consist of natural overtones or harmonics of other lower frequency sounds.

The second of these factors is the amplitude of the reproduced sound. The original signal occurring naturally may be as quiet as a whisper or as loud as a report from a gun, but the amplifier must be capable of maintaining the true relationship present between all the amplified signals.

Frequency Distortion:

Frequency distortion in an amplifier can be considered as a disproportionate reproduction of the various frequencies being reproduced, or in another way the gain of the amplifier will change with variation in frequency. The frequency response of a good quality amplifier system used for high fidelity reproduction usually is considered to embrace a range of 15 to 20,000 c/s within +− 1 db. There is invariably some loss or "roll-off" at the upper and lower extremes of the frequency range and in some cases there could be a rise or dip in response round about the middle frequencies.

A point which should be appreciated is that there is a difference between frequency response and frequency range. Modern equipment can cover the full audible frequency range, yet the response may be far from uniform. A system that has a limited but uniform frequency coverage is often more acceptable to the ear than a full range system lacking uniformity.

The next two kinds of distor-

tion which also are a function of the frequencies being reproduced are caused by the presence of amplitude dependent nonlinearity in the amplifier system.

Harmonic Distortion: This is said to occur when a single sine wave which passed through the amplifier appears at the output accompanied by frequency multiples or harmonics of itself which have been produced inside the amplifier. When more than one signal is present, the effect can be more marked, and is called Intermodulation Distortion. We will deal with this a little further on in the article. Harmonic distortion is commonly specified by the total harmonic content expressed as a percentage of the fundamental. Thus a figure of 5 per cent. total harmonic distortion means that of the total output, the fundamental (original) signal forms only 95 per cent., and the other 5 per cent. is due to harmonics introduced by distortion. As a practical example, one per cent. of second harmonic is scarcely distinguishable as a harmonic tone, but harmonics of third or higher orders and the same percentage are easily perceived. The harmonic content is invariably greatest at the upper and lower extremes of the frequency range capability of the amplifier. For a high quality amplifier the total content should not exceed 0.5 per cent. at any frequency and is often as little as 0.05 per cent. when measured at say 1000 c/s.

Intermodulation Distortion: Although a low harmonic content may not of itself affect the reproduction of a signal adversely, intermodulation products produced by harmonic inter-action with other primary tones can set up some very unpleasant effects.

Intermodulation distortion is often considered a more reliable measure of the properties of the particular amplifier system than harmonic distortion measured with a single tone, because as a general rule intermodulation distortion is approximately three to four times the single tone harmonic distortion figure. Let us examine why this is so.

When two sine waves of differing frequency are passed through an amplifier exhibiting nonlinearity, the signals coming from the amplifier are the original two tones, plus the sum of the two tones, plus the difference between the two tones. This is in fact the equivalent of one tone modulating the other—hence the name "intermodulation distortion." Because there are usually many more than two tones present, the many spurious frequencies generated by intermodulation are often not harmonically related to the originals, and consequently the resulting reproduction has a harsh and unnatural sound.

The average listener can detect intermodulation distortion when it exceeds about two to three per cent. of the peak power ability of the amplifier, that is about 1 per cent. of the average power of the amplifier.

Transient Distortion.

The statement that the frequency characteristics of High Fidelity amplifiers should be level even outside the audible range is not always accepted, in fact it seems to be incongruous to use tone controls to vary the response characteristics of an amplifier which has a normal level response. However, it is held that variations in response at frequencies high enough or low enough to be inaudible, even beyond the normal range of the programme material, nevertheless affect the reproduction.

If this extended range is absent, then transient distortion is introduced. This form of distortion is heard in the reproduction of bursts or impulses of sound having a steep wavefront characteristic but with no clearly defined frequency. The effect is most noticeable with the percussion instruments such as kettledrums and cymbals and plucked string instruments.

Good transient response is evidenced by the sharp attack, crispness and absence of any "ringing" effects following the bursts. The most common causes of poor transient response are high frequency resonances, parasitic oscillations, and poor choice of time constants of circuit components.

Phase Distortion:

Whenever reactance and resistance are present in a circuit, for instance in tone controls, rumble filters, and roll-off networks, a phase shift can occur between two tones of differing frequency. This is also true of the fundamental and harmonic components of a single note, although it is not usually discernible to the ear. A phase shift can take place if a circuit contains a filter consisting of reactive and resistive elements, or if energy is fed back spuriously from the output to the input of an amplifier stage. Although controlled negative feedback is considered beneficial in combatting other forms of distortion, varying degrees of phase shift between complex musical tones can create tonal imbalance.

We have covered all the various forms of frequency conscious distortion and now we turn to the second of the two main divisions, that of amplitude or volume distortion.

Amplitude Distortion:

Whilst the variation of output power (or voltage, or volume) with variation in frequency, can be considered to be one effect, we have already discussed this under the heading of frequency response. What we refer to under this heading is rather different. When sound is reproduced at a higher or lower level than the original, some of the realism is lost. Speech reproduced at a higher level than normally spoken sounds in many cases is unnatural and weighty, and lacks crispness. If music is reproduced at too low a level, the extreme treble and bass tones seem to be lost. This is brought about by the fact that at low levels of audibility, the ear is more sensitive to frequencies in the region of 2000 to 3000 c/s, with the sensitivity falling rapidly towards the lower and upper frequency regions. This subject introduces logically one of the major points for discussion (and argument) when amplifiers are being considered—that of the power output requirements of the amplifier. Many people

seem to confuse high quality performance with high output power capability.

Power output requirements can be related in certain respects to the frequency range to be covered. At the lower frequencies, the vibration amplitudes of the speaker system are greater, therefore demanding more power. As a case in point, an amplifier with 3 watts output is quite satisfactory for a large room, provided that the bass response of the amplifier is not required to extend below about 70 to 80 cycles. To extend the reproduction down to 30 to 40 cycles, at least 10 watts of power is required.

These figures are dependent, of course, on the efficiency of the speakers and the type of watts which are referred to. (We will discuss the different types of power ratings in the second part of this article.)

One of the reasons presented for the use of high power amplifiers is their ability to handle high peak to average power ratio transients without overloading. (See earlier discussion of transient response.)

To a limited extent this is quite true, when we remember the nature of a transient. However, we could conclude that its duration is so short that it seems hardly likely that one could discover even gross distortion in the reproduction, assuming the distortion to be there anyway.

To give a practical example let us take the case of a large orchestra, of say 70 to 80 pieces. From work carried out at the Bell Telephone Laboratories, we find that such an orchestra produced a full sound spectrum maximum or peak power of approximately 66 watts, but this level is reached during only approximately 1 per cent. of the playing time.

A level of approximately 13 watts would be reached for about 10 per cent. of the time. The main difference in the two power levels can be accounted for by the use of drums, in the frequency range below 100 c/s. and cymbals in the frequency range above 8000 c/s. Both these instruments are mentioned in the section under Transient Distortion.

Another point worth remembering is that amplifiers are often rated according to the power which they are able to deliver at, say, 1000 c/s. at a distortion figure of, say, 1 per cent. Such a type of specification, whilst useful for certain comparison purposes, is not really adequate, however, since it is quite possible that at other frequencies higher and lower, the threshold of distortion will occur at a much lower level, perhaps because of the negative feedback not being so effective at high frequencies, or owing to a loss of sensitivity in the amplifier, or because it becomes necessary to increase the input voltage to the amplifier to such an extent that it causes distortion. If the output transformer ability is limited it will reduce the amount of power available at the low frequency end of the range.

This concludes our discussion on the subject of the various forms of degradation of performance which can be considered under the heading of "distortion." There are, however, one or two other factors which will also affect the overall performance of an amplifier.

Residual Hum and Noise:

Noise is the total noise from all parts of the equipment appearing at and reproduced by the loudspeaker, when no actual programme material is being reproduced. It can originate from sources outside the amplifier itself, as well as from inside the equipment. Extraneous pops, crackles, etc., can be picked up from nearby electrical appliances or radiated into the amplifier system (this means leads and cables into and out of the amplifier as well as the actual amplifier unit) from nearby mains wiring. The internal noise is due to (a) the effects of electron movement in the components used in the equipment, which is amplified by succeeding stages (circuit noise); and (b) the noise produced by the electron bombardment of the electrodes in the tubes used in the amplifier, which is also amplified by succeeding stages (valve noise).

In addition to these two sources there is the presence of hum due to slightly imperfect smoothing of A.C. power sources and 50 c/s. pickup from A.C. flowing in filament and H.T. leads inside the amplifier itself.

Since both the noise and signal voltages are a function of the total amplification inbuilt into the amplifier, the specification of noise level from an amplifier is not a true representation of the amplifier's performance. A more valid measure of the purity of the reproduction in this respect would be in terms of signal to noise ratio. A high signal to noise ratio is considered a good criterion whilst a low signal to noise ratio is indicative of poor performance.

* * *

The author wishes to acknowledge the following articles and texts used in the preparation of this article:

Audio Frequency Standards of the Audio Manufacturers Group of the British Radio Equipment Manufacturers Association as published in Radiotronics, Vol. 27, No. 10, October, 1962.

"How to Make Music-Power Measurements," by D. R. von Recklinghausen, "Electronics World," June, 1961.

"High Fidelity Pocket Book," by W. E. Pannett, A.M.I.E.E.

"Intermodulation Distortion Measurements," by D. E. O'N. Waddington, "Electronics and Communications," January, 1964.

"Random Reflections," by B. J. Simpson, "Radiotronics," Vol. 27, No. 6, June, 1962, and Vol. 27, No. 3, March, 1962.

"Hewlett - Packard Journal," various numbers.

"From Microphone to Ear," by G. Slot. A Philips Technical Publication.

"Discussions on Distortion Meters and Measurements," by J. Rowe, R.T.V. and Hobbies, June, 1961.

"Radio Designers' Handbook," Fourth Edition, by F. Langford-Smith.

Sundry other papers and journals, too many to mention, but gratefully acknowledged.

Some Aspects of V.H.F. Mobile Operation

PART V.

by Irving Spackman, ZL1MO

This month, in the final section of discussion, we will attempt to analyse some of the problems and requirements of a suitable V.H.F. receiver system for use in a vehicle as part of a V.H.F. mobile installation.

When the author first became interested in two metre mobile, an intensive search was made through many of the overseas publications, both past and current, for some details which could have been of assistance in making a decision as to what type of equipment should be used. To the author's great surprise, there was very little information available. Some of the ideas which were offered, however, may be of use to our readers, so they have been briefly outlined here.

1. Various types of "Command" receivers of the ARC 5 series were suggested. The one most commonly used was the 3-6 mc. range version either used as is, or with the tuning range modified for tuning 14 megacycles up. In the range 3-6 mc/s the 80 metre band can be tuned from 3.5 mc/s to 3.9 mc/s and half of two metres can be tuned from 4-6 mc/s.

Generally speaking, the selectivity of the 1415 k.c. I.F. channel is reasonable, but can prove troublesome if there are a number of stations within 10 or 15 k.c. of each other (this does happen in Auckland very often).

The receiver is quite compact, but requires extra work done on it to provide a good A.V.C. system and noise limiter. Usually there is also insufficient audio gain available, and the output transformer must be altered to feed a normal loud speaker. Such a receiver as this would normally and logically follow a good crystal controlled converter.

2. A second rather common receiver design is outlined as follows. The system is a simple superhetrodyne with R.F. stage, mixer and tunable local oscillator. The I.F. chain operates at a frequency of between 10 and 30 megacycles, and consists of a one or more I.F. amplifier stages transformer coupled and followed by a superregenerative detector.

This type of detector while relatively broad in frequency bandwidth does have two redeeming features. These are an excellent A.V.C. characteristic and good impulse noise limiting ability. Also the detector is very sensitive, being capable of good audio output from a signal as little as 5 micro-volts.

The author tried out a system such as this using 1 stage of I.F. amplification at 10 megacycles followed by a superregenerative detector at the same frequency. The performance of the system was very good except for one thing, the lack of selectivity.

3. A third suggested method was to use a tunable converter feeding into a second I.F. chain at 4.5 mc/s, then heterodyning to 455 k.c. An adaptation of this method was to use the usual car broadcast receiver as the second and third I.F. frequency, detector and audio. These methods have a number of problems, some of which are explained as follows:

If a tunable oscillator at 140 mc/s is used with the selectivity of a 455 k.c. I.F. channel, it is rather difficult to hold the local oscillator frequency sufficiently stable due to varying voltage and vibration problems when in motion.

If a fixed tuned or crystal controlled converter is used feeding into the broadcast receiver via an intermediate mixing or conversion stage, there are two problems. One is the 1 mc/s tuning range of the car receiver, plus the fact that it has to be modified to include a noise limiter and a possible B.F.O., and the tuning rate of many broadcast receivers is not good enough for communication purposes, whilst H.T., A.V.C. and filaments need to be drawn from the car receiver. If no A.V.C. is used on any stages prior to the car receiver, then the A.V.C. control is usually not adequate for extensive V.H.F. mobile operation. The second factor is that with the increased number of heterodyning stages and associated local oscillators, it is essential that these are carefully arranged frequency-wise since a number of "spots" can appear where harmonics of the lower frequency oscillators fall into the tuning ranges of the higher frequency stages. Inevitably one of these spots always seems to coincide with the frequency of a station which is being worked.

4. A method used in what perhaps is one of the most popular two metre transmitter-receiver combinations in the U.S.A., the Gonset "Communicator" Series 1, 2 and 3, is to use a single conversion down to a 6 megacycle I.F. chain. This has the selectivity sharpened up as much as practical by using extra I.F. tuned transformers within the limit of the drift in the high frequency oscillator.

Having digested this information and much more, other vital factors can now be considered.

At first glance there is no choice between the use of valves and transistors in mobile receiving equipment of this type. Obviously a fully transistorised receiver is the only way. But! and this is quite a big "but"—a transistorised receiver does have a number of problems which have to be tackled before a fully acceptable transistorised receiver design becomes a reality.

Once again, we will introduce one or two points which have some bearing on the final result.

(a) Transistorised versus Valve R.F. Stages:

At the present time, transistors, suitable for operation as R.F. amplifiers and mixers are available at reasonable prices. The upper frequency limit of some of the current types is beyond 500

megacycles, so there is no problem at frequencies in the range of 150 megacycles. However, most, if not all of these transistors have very low base to emitter junction breakdown voltages, and so these transistors must be adequately protected when operated in the presence of strong R.F. fields such as those present near a transmitter. Even the antenna changeover relay (which is a virtual necessity) must provide reasonable isolation for the receiver terminal when connecting the transmitter to the antenna. Many of the designs for transistor R.F. stages show a protection diode connected in series with a $1\frac{1}{2}$ volt reverse biasing battery across the antenna coupling coil. This will limit the maximum R.F. voltage to the transistor to a safe figure. Another approach is to remove the supply voltage to the converter or receiver and also open the emitter return of the R.F. stage so that there is no likelihood of damaging current being produced across the base-emitter junction.

In common with transistors, many of the high slope R.F. amplifier tubes also will not tolerate much R.F. power applied on their control grid. However, there are many which will, so much so, in fact, that there have been a great number of commercial V.H.F. radio telephones which operated for many years with the R.F. stage grid capacitively coupled to the final tank circuit, and with the final tank of the transmitter operating as the aerial coil for the receiver. Even the rather touchy 6AK5 was known to stand up in this type of service.

In the case of both valve and transistor R.F. stages, there is no real problem in obtaining a satisfactory signal to noise ratio or noise figure performance.

(b) A.V.C. Characteristics:

In mobile operation there is found a wide and often rapidly occurring variation in field strength. This can vary up to 40 dB. or more, in the space of a few yards. Consequently, the receiver has to be able to cope with signals as strong as 10 millivolts and as weak as half a microvolt. Whilst the receiver sensitivity to cope with the weak signals is no real problem, in many cases the ability of the receiver to cope with the strong signals is often marginal. As a general rule, valve type receivers, including those of the low anode voltage type, have better A.V.C. and overload characteristics than comparable transistorised receivers. This is not to say that a transistor receiver cannot be designed with a good A.V.C. and overload condition, but it cannot be done so easily with only 5 or 6 transistors.

(c) Power Supplies:

Whilst a fully transistorised receiver can be operated on less battery drain than the light behind the dash panel of an average car, one must be careful not to exaggerate the problem of battery consumption. A suitable type of valve receiver would probably use about 1 ampere at 12 volts for filament power and 50 to 60 milliamperes at 150 to 200 volts for high tension supply. This means (when a modern transistorised H.T. supply is used) that the total battery drain for the receiver will be of the order of $2\frac{1}{2}$ amperes (at 12 volts). This is not very much (about the same as the parking lights of a modern car), if even a reasonable amount of driving is carried out. When a transistorised power supply is in use for the transmitter, there is every likelihood that there will be a half-voltage tap available and suitable for operating the receiver (see discussion in this series in the April issue on transistorised power units). Under these conditions a section of the transmit-receive relay can be used to change the H.T. over from the receiver to the transmitter exciter, thus quickly interrupting the receiver and obviating any likelihood of acoustic feedback. The reverse condition, where the transmitter is quietened before the receiver comes to life, is also effective. The use of a continuously operating H.T. source can often obviate the necessity for a heavy current relay to operate the power unit on transmit only, worked by part of the microphone pressel switch circuit. Turning on the main filament switch can start the power unit.

(d) The Effect of Heat on Transistor Equipment:

For the sake of compact and tidy installations, it is often necessary to locate the receiver and transmitter in the same case. Most germanium transistors are sensitive to heat, and whilst normal stabilisation techniques can iron out most of the problems up to say a working temperature of 45 to 50 degrees centigrade, the effects of heat on transistors used in tunable local oscillator service can be very marked and very annoying. The change in characteristic with temperature rise manifests itself in a change of frequency of the oscillator, and the drift often can be of marked proportions.

Whilst the heat effects will also be caused by the variation in the L and C components of the local oscillator, these do not seem to be as prominent as those effects caused by the heat effects on the transistor itself. In this respect, vacuum tubes are not critical as regards their working temperature, provided that the frequency determining parts such as the tunable local oscillator are correctly designed and located in the main assembly.

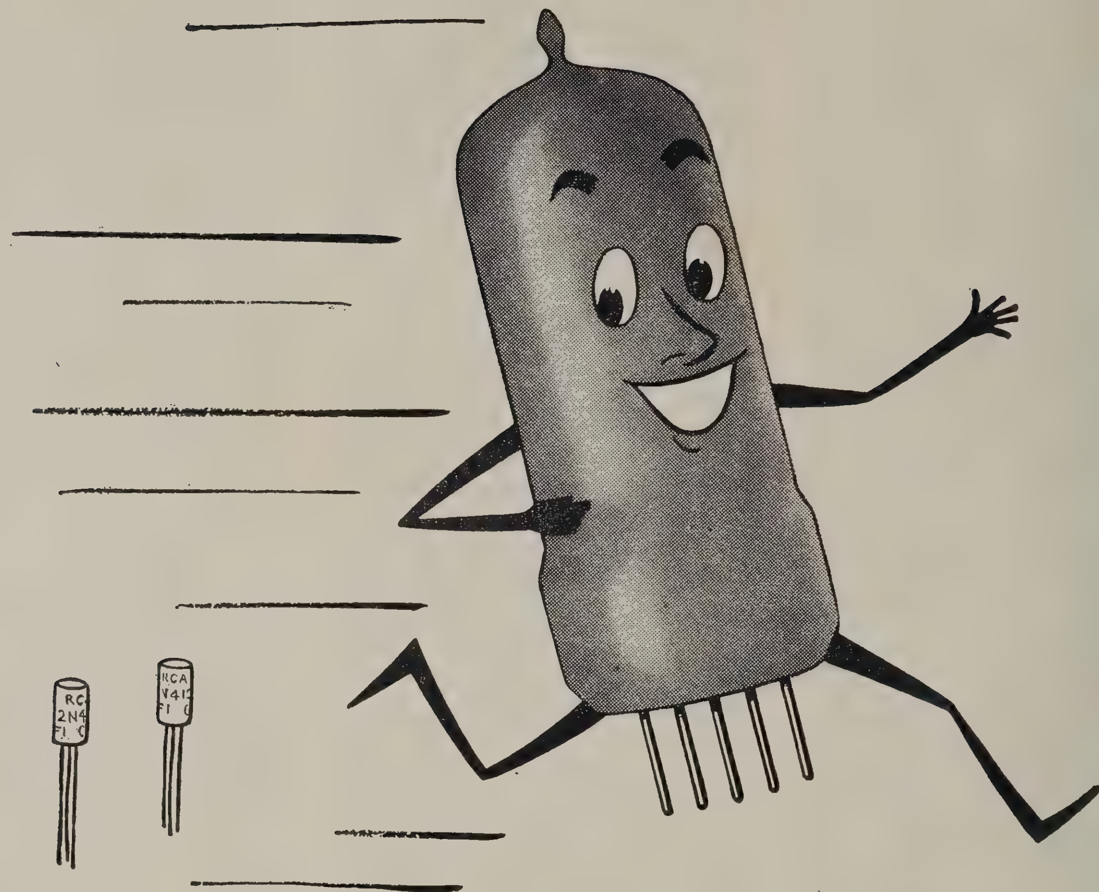
As mentioned earlier, a transistorised converter or full receiver will require an antenna change-over relay, but if a valve type of receiver is used then there is a good chance that a "T-R Switch" type of circuit can be utilised in the R.F. stage input circuitry and therefore obviate the need for such a relay.

Perhaps it should be mentioned here that an antenna relay should be used with both the ECC86 converter and the AF102 transistorised converter described earlier in this series.

Now let us turn briefly to some of the other technical problems. First we shall examine the factors associated with the selectivity of the receiver, in other words the I.F. bandwidth.

The motor vehicle produces a large amount of electrical noise throughout the radio frequency spectrum. In the case of the

please turn to page 28



Circuit and service — Murphy Television Receiver — Model VCG 343

ALIGNMENT PROCEDURE

When two positions of the core appear to give the correct adjustments, the following apply:

- * Coil tuned with core close to chassis.
- † Coil tuned with core close to can top, i.e., remote from chassis.

Make sure that bias voltages are correct, as incorrect voltages will lead to wrong adjustment.

When applying markers use smallest marker visible, otherwise response could be incorrectly displayed, i.e., removal of the marker generator should not change viewed shape of response.

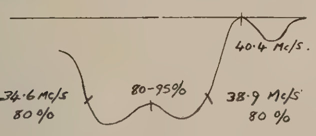


Fig 1

Make sure that responses are viewed at correct output level as incorrect level will result in wrong adjustment. At lower levels, detector non-linearity affects the shape, and at higher levels overload will alter the shape of the response.

SOUND I.F. ALIGNMENT

Connect the unmodulated output of an accurate signal generator to the video detector test point and set the frequency to 5.5 Mc/s.

Short circuit pin 1 of V203 (3rd video i.f. grid) to ground.

Connect the VTVM d.c. probe to the sound peak test point and set the range switch to + 5 volts d.c.

Adjust the following cores for peak output varying the input to maintain a reading of about 3 volts.

TR 101 Secondary (Ratio Detector bottom core)*
TR 101 Primary (top core)†
L 101 (Sount Take Off Coil)*
L 206 (Sound Trap)*

Repeat this sequence once.

Transfer the VTVM probe to the sound zero test point.

Readjust TR101 secondary (bottom core) for zero reading on the VTVM.

Set the calibrator modulation switch to 600 c/s.

Connect the c.r.o. to the video out test point through a crystal probe.

Readjust L206 (sound trap)* for minimum 600 c/s on the c.r.o.

Remove the signal generator, VTVM, and short circuit on V203 grid.

VIDEO I.F. ALIGNMENT

Turn VR301 to extreme clockwise position when viewed from the wiring side.

Connect a source of –3 volts bias to the video i.f. at pin 2 of L202 and a source of –2 volts bias to the tuner A.G.C. terminal.

Connect junction R304 and R305 to earth.

Connect the sweep generator to the aerial input terminals on the tuner and set both sweep generator and tuner to Channel 4.

Connect a c.r.o. vertical input to test point of mixer grid on the tuner through a shielded lead.

Check that the r.f. response viewed on the c.r.o. conforms with that shown in the tuner alignment section.

Disconnect the c.r.o. from test point on the tuner and connect a crystal detector probe to pin 5 of V201 (1st video i.f. plate) and also by-pass pin 5 of V202 to ground with a 001 utd. capacitor.

Set tuner oscillator frequency 214.15 Mc/s plus and minus 0.5 Mc/s using the fine tuning control. Set the sweep generator output to give maximum deflection on the c.r.o. of 0.3 volts p.p. It is suggested that the marker generator be connected to the centre spigot on the socket of V201 and the earth lead connected to the chassis.

Set the marker generator 40.4 Mc/s and adjust L201* (top core) so that the marker appears in the dip of the response produced by the trap, i.e., tune the trap to 40.4 Mc/s.

Adjust TR2*, L202* and trimmer C204* to produce the response on the c.r.o. shown in figure 1.

TR2* mainly affect 38.9 Mc/s marker position.

L202* mainly affect tilt (bottom core).

C204* mainly affect the bandwidth.

OVERALL ALIGNMENT

Remove the crystal probe and connect the c.r.o. to the video detector test point using the video lead network.

It is suggested that the marker generator remain connected to the centre spigot of V201 socket.

View overall response with approximatelv 3 volts p-p output and adjust the accompanying sound trap TR202 (top core)† for minimum response at 32.9 Mc/s increasing the c.r.o. gain if necessary for easier adjustment of the trap.

Reset the c.r.o. gain to give 3 volts p-p and adjust for a response as shown in figure 2.

Marker 38.9 Mc/s at 30% TR202*
Marker 32.9 Mc/s at 4-5% TR201*
No tilt TR203*

Check that 34.65 Mc/s marker is at 55-70%, otherwise readjust TR201* and correct tilt with TR203* if necessary.

Reduce applied I.F. bias to zero and check that the response curve is between figs. 2 and 3.

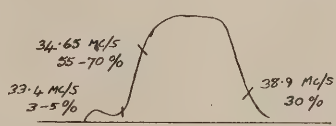


Fig 2 OVERALL RESPONSE –3V I.F. BIAS

ADJUSTMENTS

FOCUS

This adjustment has been made at the factory and should only need re-adjustment if the picture tube is replaced. In this case, adjust the focus control, situated on the chassis itself below the 6AU4 damper diode, until maximum definition of the line structure of the rastor is obtained.

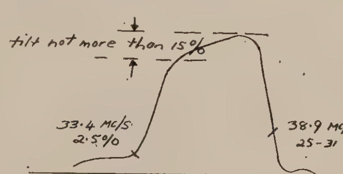


Fig 3 OVERALL RESPONSE ZERO I.F. BIAS

HORIZONTAL OSCILLATOR ADJUSTMENT

Normally the adjustment of the horizontal oscillator is not considered to be part of the alignment procedure. The adjustment is made at the factory and should not require re-adjustment in the field. However, the adjustment should be carried out whenever the horizontal oscillator is incorrect. The width should be correctly set before adjusting the "Sine Wave" stabilising coil.

The horizontal oscillator may be adjusted by the following method:

(a) Short circuit the "Sine Wave" stabilising coil L401.
(b) Connect a high impedance D.C. voltmeter from pin 2 of V402 to earth and adjust the horizontal hold control for a reading on the meter of 0 volts.
(c) Remove the short circuit from the "Sine Wave" stabilising coil L401 and adjust the iron core of this coil until the meter indicates 0 volts when the picture is synchronised.

WIDTH AND HORIZONTAL LINEARITY ADJUSTMENT

Connect a vacuum tube voltmeter, adjusted for –50V D.C., to junction R337 and R338. Adjust horizontal linearity coil L403 for maximum negative voltage as indicated by the voltohmyst. Adjust width control VR401 for ½in. overscan at each side. Do not overscan more than necessary. Re-adjust linearity coil for best overall linearity.

HEIGHT AND VERTICAL LINEARITY ADJUSTMENTS

Adjust height control until picture fills approximately three-quarters of the screen.

Adjust vertical linearity to give a small amount of cramp at top of picture.

Increase picture height control until correct overscan is achieved at the bottom of the picture.

Adjust top linearity to give correct overscan at the top.

Height and linearity controls should then be adjusted in conjunction with one another to give best linearity, and ½in. of overscan top and bottom.

D.C. RESISTANCE OF WINDINGS V343 - Z283

Winding		D.C. Resistance in OHMS
Tuner Windings		*
L 101	Sound I.F.	*
L 201-2	Video I.F. Input and Trap	*
L 203	I.F. Filter Choke	4
L 204	I.F. Filter Choke	*
L 205	Video Peaking Coil	6
L 206	5.5 Mc/s Trap Coil	1.5
L 207	Video Peaking Coil	5
L 401	Sinewave Coil	55
L 402	H.F. Filter Choke	*
L 403	Horizontal Linearity	6.3
L 404	Deflection Coil	2.5
L 405	Deflection Coil	2.5
L 406	Deflection Coil	17
L 407	Deflection Coil	17
L 408	H.T. Filter Choke	40
TR101	Ratio Detector	
	Prim 1-6	9.5
	Sec. 3-4	1
TR102	Sound Output	
	Prim	370
	Sec.	*
TR201	1st Video I.F.	*
TR202	2nd Video I.F.	*
TR203	3rd Video I.F.	*
TR301	Vertical Blocking Oscillator	
	Prim Bu-Gr	525
	Sec. Red-Ye	163
TR302	Vertical Output	
	Prim Bu-Rd	350
	Sec. Ye-Rd	2.5
TR401	Horizontal Blocking Oscillator	
	Ye-Anode	24
	Ye-C407	88
TR402	Horizontal Output	
	1-2	1.52
	3-4	3.3
	3-8	7.0
	3-7	10.1
	3-6	18.3
	3-5	23.3
	5-Anode	415
TR403	Focus	
	Prim Ye-Rd	1.5
	Sec. Bk-Wh	525
TR404	Mains	
	Prim Wh-Wh	7
	H.T. Sec Rd-Rd	4.3
	Heater Secondaries	*

* Less than 1Ω

The above readings were taken on a standard chassis at 20°C but different materials used in manufacture may cause variations, and it should not be assumed that a component is necessarily faulty if a slightly different valve of resistance is measured.

NOTES—

1) WAVEFORM VOLTAGES—
COMPOSITE VIDEO WAVEFORMS SHOWN VARY WITH CONTRAST SETTING.
VOLTAGES WITHIN THE WAVEFORMS MEASURED ON A VOLTOHMYST (PEAK TO PEAK.)
VOLTAGES BETWEEN ARROWS MEASURED ON C.R.O. USING LOW CAPACITANCE PROBE.

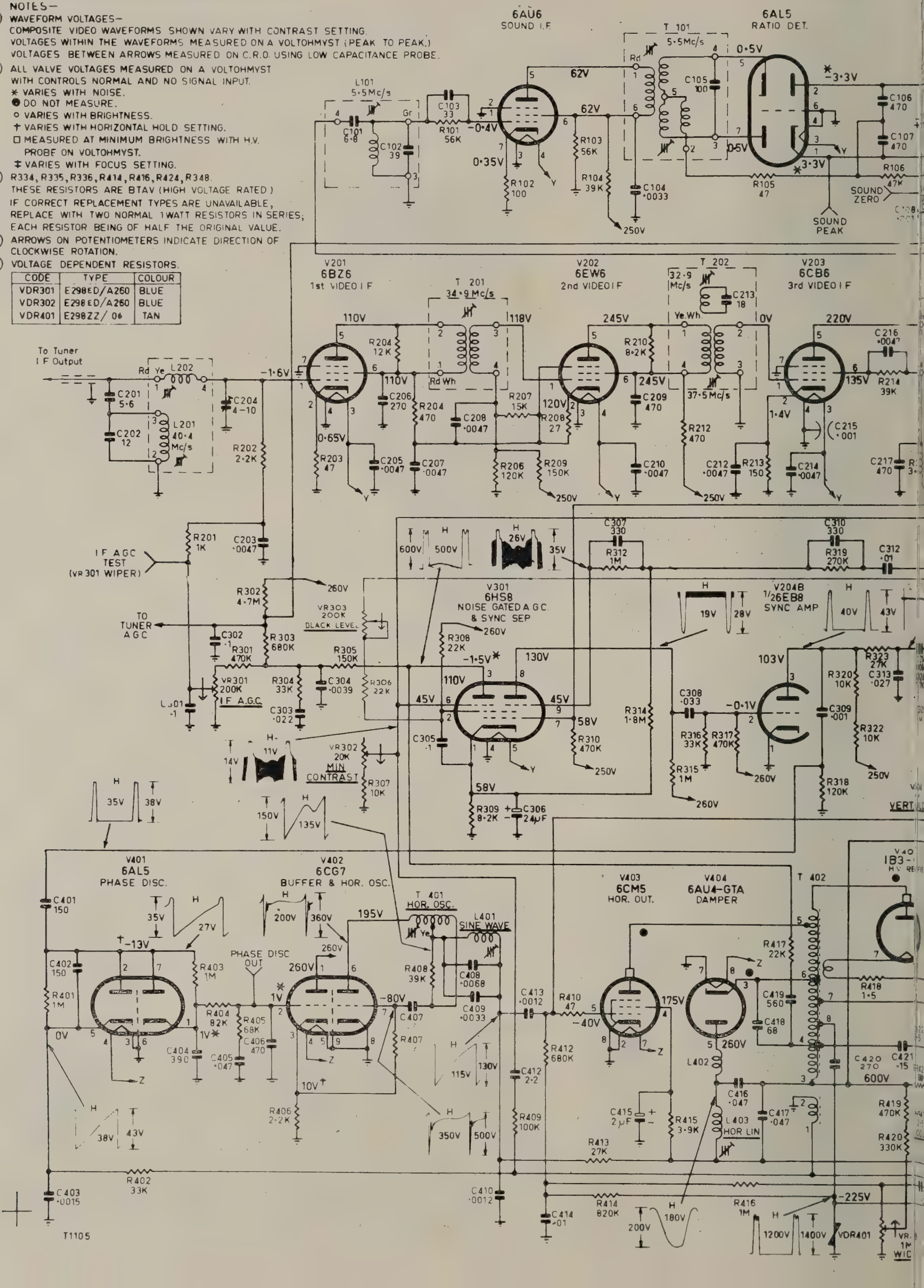
2) ALL VALVE VOLTAGES MEASURED ON A VOLTOHMYST WITH CONTROLS NORMAL AND NO SIGNAL INPUT.
* VARIES WITH NOISE.
● DO NOT MEASURE.
○ VARIES WITH BRIGHTNESS.
† VARIES WITH HORIZONTAL HOLD SETTING.
□ MEASURED AT MINIMUM BRIGHTNESS WITH H.V. PROBE ON VOLTOHMYST.
‡ VARIES WITH FOCUS SETTING.

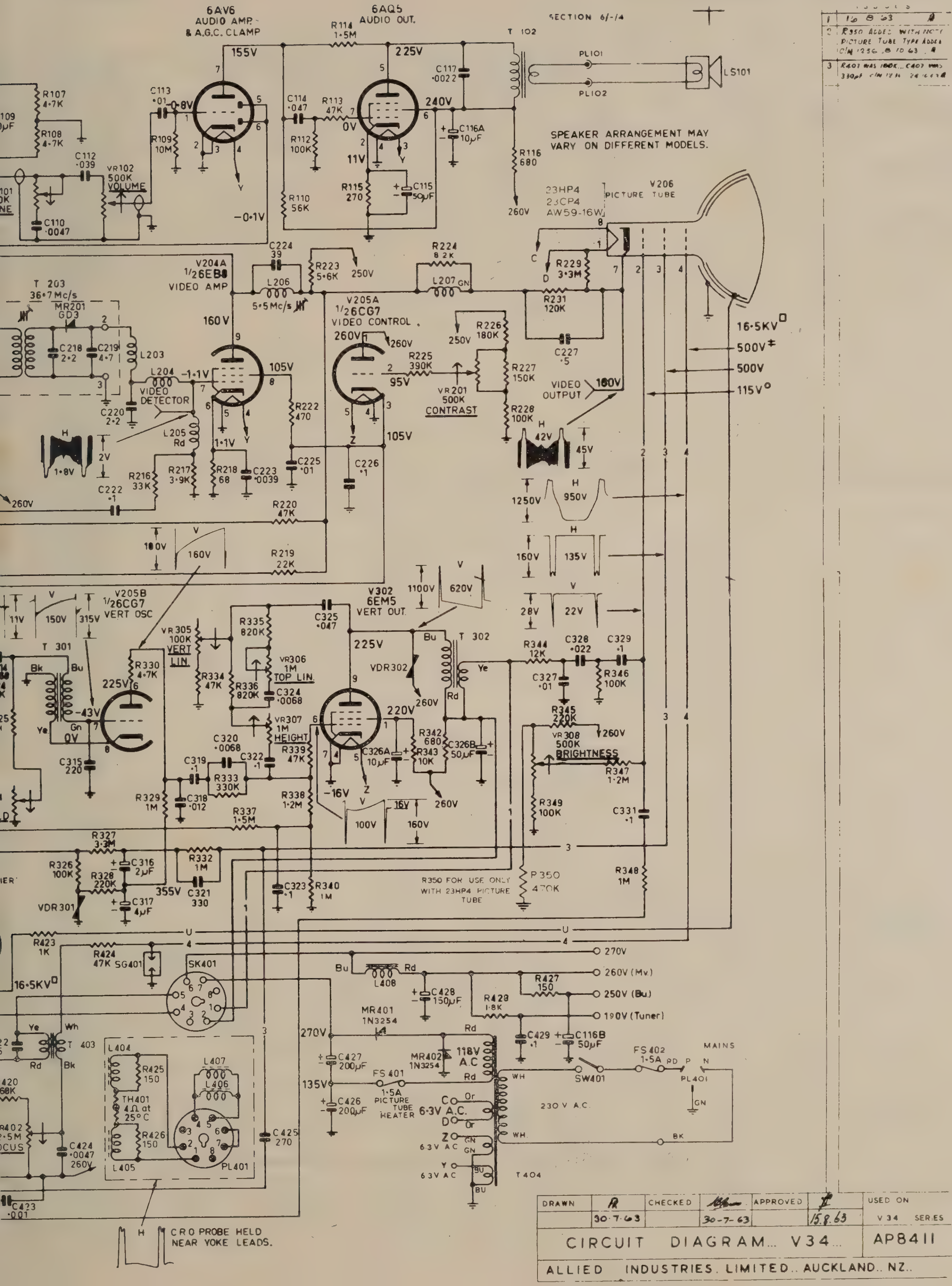
3) R334, R335, R336, R414, R416, R424, R348.
THESE RESISTORS ARE BTAV (HIGH VOLTAGE RATED)
IF CORRECT REPLACEMENT TYPES ARE UNAVAILABLE, REPLACE WITH TWO NORMAL 1 WATT RESISTORS IN SERIES; EACH RESISTOR BEING OF HALF THE ORIGINAL VALUE.

4) ARROWS ON POTENTIOMETERS INDICATE DIRECTION OF CLOCKWISE ROTATION.

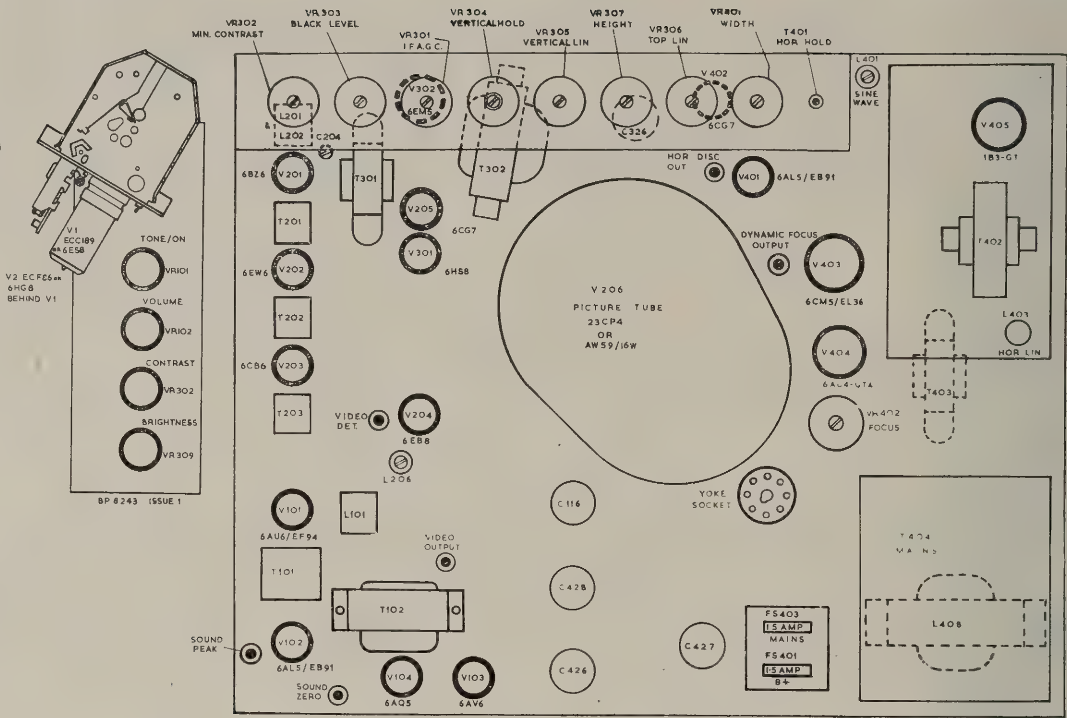
5) VOLTAGE DEPENDENT RESISTORS.

CODE	TYPE	COLOUR
VDR301	E298ED/A260	BLUE
VDR302	E298ED/A260	BLUE
VDR401	E298ZZ/06	TAN




6AV6
AUDIO AMP. & A.G.C. CLAMP
6AQ5
AUDIO OUT.
SECTION 6/-/4
T 102
PL101
PL102
LS101
SPEAKER ARRANGEMENT MAY VARY ON DIFFERENT MODELS.
23HP4
23CP4
AW59-16W
V206
PICTURE TUBE
VR102
500K
VOLUME
V204A
1/26EB8
VIDEO AMP
T 203
36·7 Mc/s
MR201
GD3
VIDEO DETECTOR
V205A
1/26CG7
VIDEO CONTROL
VR201
500K
CONTRAST
VIDEO OUTPUT
16·5KV
500V
500V
115V
V205B
1/26CG7
VERT OSC
T 301
VR305
100K
VERT LIN
VR306
1M
TOP LIN.
VR307
1M
HEIGHT
V302
6EM5
VERT OUT.
T 302
VDR302
VR308
500K
BRIGHTNESS
R350 FOR USE ONLY WITH 23HP4 PICTURE TUBE
VDR301
SK401
SG401
L408
MR401
1N3254
MR402
1N3254
FS401
1·5A
PICTURE TUBE HEATER
6·3V A.C.
118V A.C.
230 V A.C.
FS402
1·5A
SW401
PL401
MAINS
T 404
270V (Mv)
260V (Mv)
250V (Bu)
190V (Tuner)
T 403
TH401
4 Ω at 25°C
L404
L405
L406
L407
CRO PROBE HELD NEAR YOKE LEADS.
DRAWN
CHECKED
APPROVED
30-7-63
30-7-63
15.8.63
USED ON
V 34 SERIES
CIRCUIT DIAGRAM... V34...
AP8411
ALLIED INDUSTRIES. LIMITED.. AUCKLAND.. NZ..

MURPHY Model VCG 343 Television Recevier



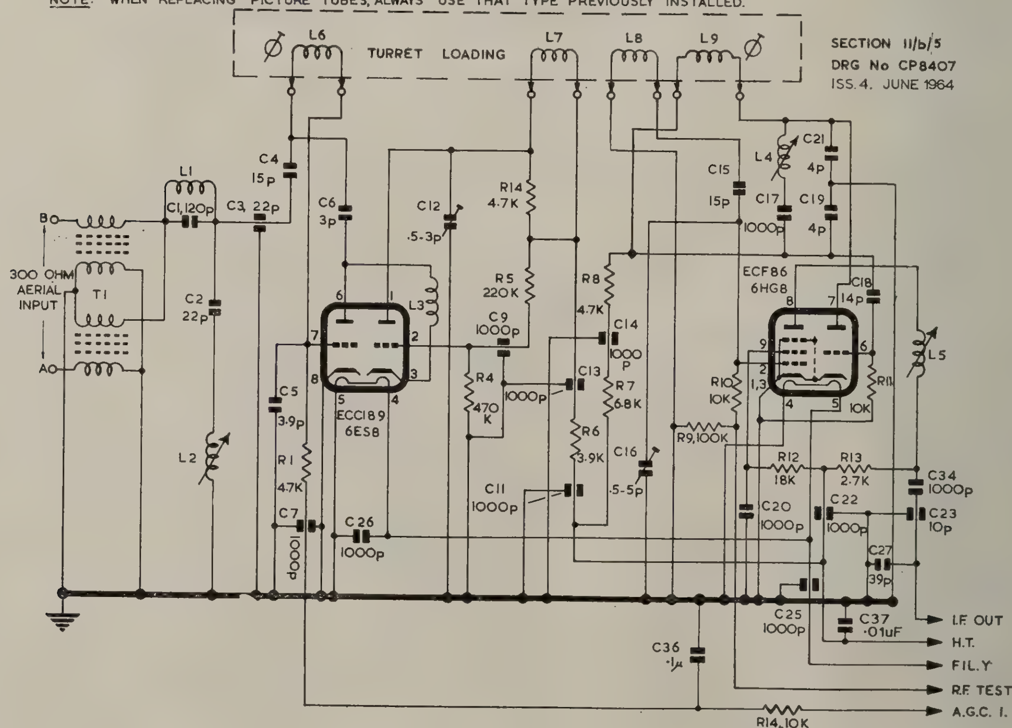
Chassis Layout And Valve Functions

VALVE FUNCTIONS

V1 6ES8/ECC189	R.F. AMPLIFIER IN TUNER	V205 6CG7	VIDEO CONTROL & VERT. OSC.
V2 6HG8/ECF86	R.F. OSCILLATOR & CONVERTER	V302 6EM5	VERTICAL OUTPUT
V101 6AU6/EF94	1ST SOUND I.F.	V401 6AL5/EB91	PHASE DISCRIMINATOR
V102 6AL5/EB91	RATIO DETECTOR	V402 6CG7	BUFFER & HOR. OSCILLATOR
V103 6AV6	AUDIO AMPLIFIER	V403 6CM5/EL36	HOR. OUTPUT
V104 6AQ5	AUDIO OUTPUT	V404 6AU4-GTA	EFFICIENCY DIODE
V201 6BZ6	1ST. VIDEO I.F.	V405 1B3-GT	HIGH VOLTAGE RECTIFIER
V202 6EW6	2ND. VIDEO I.F.	MR401, MR402	1N3254 or OA210 SILICON DIODE RECTIFIERS
V203 6CB6	3RD. VIDEO I.F.	MR201 OA160/OA70	VIDEO DETECTOR
V204 6EB8	VIDEO OUT. & SYNC. AMP.	FS401, FS403	1·5 AMP. FUSES
V206 AW59/16W or 23CP4	PICTURE TUBE		
V301 6HS8	NOISE GATED A.G.C. & SYNC. SEP.		

NOTE: WHEN REPLACING PICTURE TUBES, ALWAYS USE THAT TYPE PREVIOUSLY INSTALLED.

Circuit Diagram AB Metal Tuner



SERVICEMAN'S COLUMN

Conducted by J. Whitley Stokes

I had thought to commence this month's column with a list of corrections of what appeared in print in the April issue but decided to leave things as they are and start with a clean slate and the devout hope that no future corrections will be necessary.

P.L. (Napier) whose letter to the Editor some months ago was the subject of comment by me, has recently sent along some material for inclusion in this column, but in doing so places me in a rather awkward position. It appears he is one of those not inconsiderable numbers of people engaged in the electronics industry who undertake radio servicing on a part-time basis in addition to a regular job. It has been my experience that full-time servicemen are apt to look down their noses at the part-timer even if he confines his activities to working on sets belonging to friends or relations. It also brings up the old question of whether such persons should be able to buy parts at wholesale prices and whether they should be recognised by manufacturers when requesting service information.

Be that as it may, I do consider that a manufacturer who refuses to supply parts, particularly imported items such as transistors, which may be in short supply, to other than the man whose very livelihood is at stake, is only doing the right thing. Regarding N-P-N transistors, to my knowledge there is only one N.Z. manufacturer using this type of transistor and I have never had any difficulty in obtaining replacements from the distributors. Does that answer your question P.L.?

The problem of having to improvise is by no means a new one, at least to anyone whose experience goes back to the days when there were more imported than locally made receivers on the market. In the post-war years we became used to nothing but locally made sets, of course, and when the odd traveller from overseas or "new" New Zealander came up with something else it was quite an object of wonder. More recently the boom in overseas travel has resulted in virtually every returning wanderer bringing back the inevitable "transistor" with its attendant twin problems of lack of service information coupled with, in most cases, lack of replacement parts. It is in such cases that the serviceman's need to improvise is most pressing.

Speaking of returning wanderers, a bloke walked in recently with a Japanese transistor set which he had purchased at some port of call en route to London. Unfortunately the thing had given out on him during his sojourn in that metropolis and he had duly taken it in to a conveniently located repair shop. However, the only outcome of this was a still defunct radio with now a lot of funny little bits rattling round loose inside and a bill for 10/- for "examining" his set. "Look! Here it is," he exclaimed, waving the receipt under my nose. I was sufficiently interested to examine the bill, on which was inscribed "To testing and examining radio, 10/-", in addition there was a little note on the reverse side stating that it would cost over £4 to repair the set. But why all the loose pieces, amongst which was a transistor with one lead broken off, I wondered? I questioned the owner. "The chap said he had to take all those bits out in order to find out what was wrong with it," he replied.

Even a doctor completing a post-mortem takes the trouble to tidily sew up the loose parts inside the corpse, or so I am given to understand.

Well, if you're expecting an interesting "I dunnit" report on this case you're going to be disappointed. I might add that it needed only a cursory inspection of the innards to come up with the pronouncement, "It's a write off."

The owner had really expected it as he said resignedly, "I thought you'd say that."

However, I wasn't to be rid of him so easily for he continued, "I've got another set out in the car, I'll just go and get it."

The next offering turned out to be a diminutive five valve AC-DC model of English manufacture which he had also brought back with him. In this case the set had been dropped, since when it had been inoperative. He quite expected this to be beyond repair, too, I think, but I was able to assure him that after a couple of bent control shafts had been straightened up and a broken wire or two resoldered the set would be as good as new. Well almost . . . actually there were quite a few pieces of the plastic cabinet missing—but the thought that at least one of his trophies could be salvaged seemed to make up for that.

(Continued overleaf)

P.L. writes as follows:

Another trap for beginners is a popular transistor portable on which the screw holding the printed board into the case is neatly hidden behind the metal dial face, and then on the printed circuit itself the metal frame of the speaker acts as part of the circuit, so that if you remove the speaker to get at an obscure fault on the board, the set won't go at all, even after you have fixed the fault, until you connect the speaker mounting posts to the frame of the speaker. The speaker wires appear to be single-strand tinned iron, and if you move it around too much, next thing you're examining the board with a magnifying glass trying to find where the wires came from! There is something to be said in favour of this model, though; at least it uses transistor types which are easily replaced. I never feel very happy when I start tracing a fault in one of those sets which uses npn transistors in mixer and I.F. circuits; where does one obtain a high-frequency npn replacement, if it should prove to be needed? (Perhaps one of the advertisers in this magazine would know of a source of supply). Sometimes it is not too hard to rewire one of the I.F. stages to use an OC45, and use the npn type thus obtained to take the place of another one, in perhaps the mixer circuit, which is not so easily rewired.

SERVICE HINTS— CASE HISTORIES

Pye TV Model 233 (T 20 Chassis)

Symptom—picture very dark even with brightness control full on.

Cause—open circuit R38, 390K ½W in cathode of C.R.T.

Remedy—use 1 watt type for replacement. Note, this resistor may be readily checked and replaced without swinging down the chassis as it is just alongside V9 the sync. separator valve. Incidentally if you find a resistor in series with the slider of the brightness control this is correct, although it is not shown on the schematic diagram it appears on the parts list as R105 (120K). Its function is to provide sufficient impedance between the C.R.T. grid and earth for the line and frame retrace blanking pulses to be developed across even when the brightness is turned down low.

La Gloria 23in. T.V.

Symptom—no picture, sound weak, raster O.K.

Cause—video amp. plate resistor (4.2K 5W w/w) open circuit.

Remedy—nearest stock size 4.7K may be used for replacement.

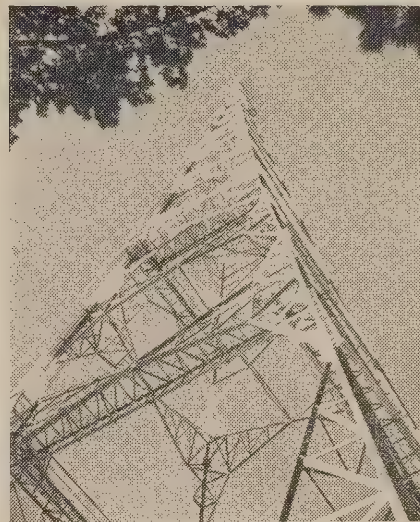
Philips— 291A 21in. T.V.

Symptom—no sound or picture, valves not lighting, heater fuse blown.

Cause—first heater chain bypass condenser, .0056 uF 400V shorted.

Remedy — replacement with ceramic type should give greater safety margin as according to people who should know a 400vDC working polyester condenser is of too low a voltage for use on 240v AC.

PLANNING A TELEVISION TRANSMITTING STATION

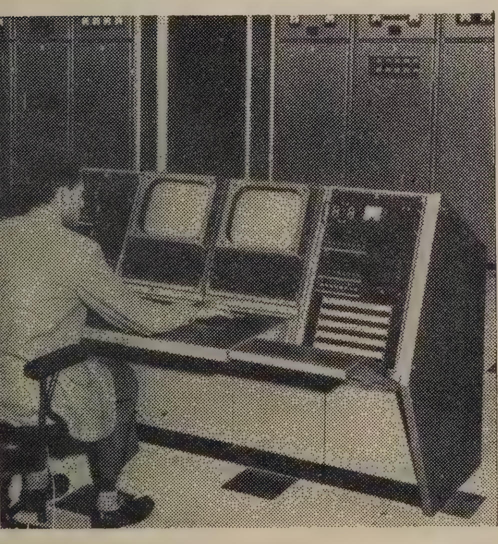


In this article it is intended to give a very general outline of the factors involved in planning a Television Transmitting Station and then to make specific reference to the four high power stations which are due to be inaugurated by the New Zealand Broadcasting Corporation during 1965.

Every Television Transmitting Station needs careful planning from the outset in order to achieve the maximum efficiency of service in the most economical manner possible and very much depends upon the optimum site and the design and positioning of the aerial system as well as upon the electrical equipment to be used. It would be well to emphasize the key phrases "maximum efficiency of service" and "the most economical manner possible" for it will be seen that all other considerations give way to these.

Signal Strength

The function of a Television Transmitting Station is to provide a satisfactory "signal" to the largest possible population consistent with technical requirements and economic limitations. What is a satisfactory television signal?



Man-made interference usually determines the signal strength required for a satisfactory television signal and this interference will obviously be most serious in the very areas of high population density that it is most important to serve. It is therefore essential to provide Grade A signals over cities and large towns. In country areas where the likelihood of interference is less the field strength necessary to provide first-class reception may be much lower and Grade B signals are acceptable. Grade A is usually based on a figure of 68dbs or thereabouts above 1 microvolt per meter and Grade B is about 47 dbs above 1 microvolt.

Industrial and other man-made noise sources usually have more effect at the lower VHF television channels, but these channels are usually favoured because of the better propagation characteristics over the uneven terrain most often encountered.

Effective Radiated Power

It is useful to employ a single term to talk about the combination of transmitter power and the aerial and this term is the Effective Radiated Power (E.R.P.). The E.R.P. is normally defined as the product of the transmitter output power and the gain of the aerial with transmission line losses taken into account.

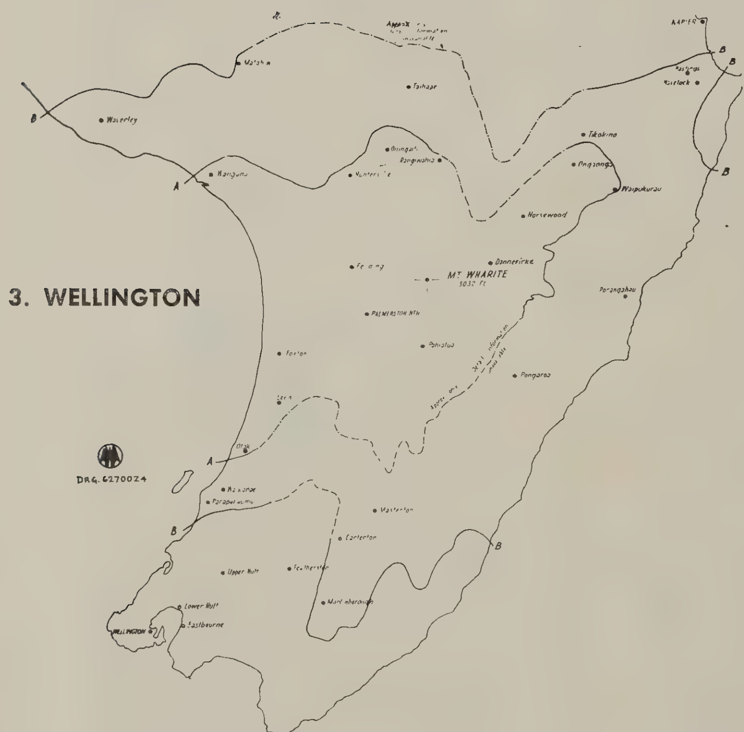
Extent of Service Area

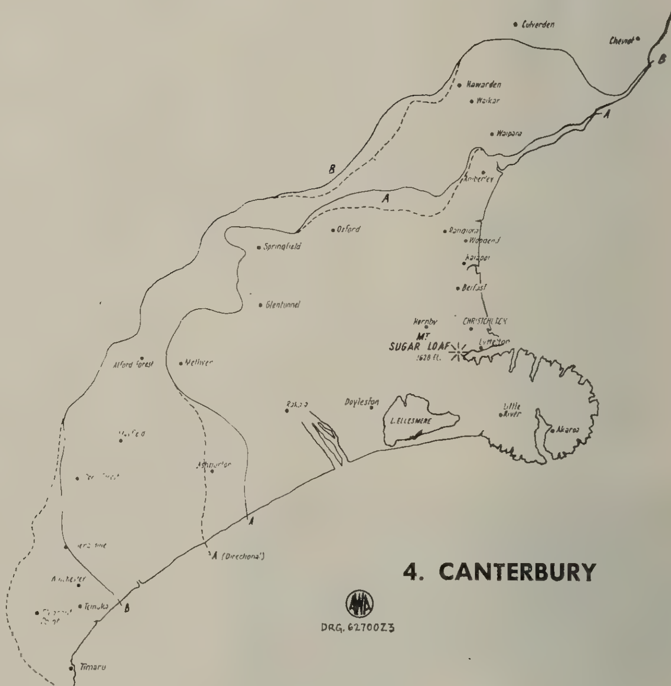
For a given E.R.P. it is possible to predict without recourse to a practical survey, the approximate service area of a particular transmitter. This amounts to a comprehensive paper study based upon theoretical and empirical propagation curves published by C.C.I.R. and upon fundamental principles of diffraction and atmospheric reflection. If the height of the transmitting site is known and the frequency of radiation has been determined, such a study will indicate fairly clearly, the contours of the Grade A and Grade B service areas and hence the signal strength which will be available to the average "receiver" will be known. Let us now consider the factors which determine the height of the transmitting site.

Height of Transmitting Site

The mean aerial height has more effect on the service area than does the effective radiated power of the station and measurements have shown that a greater increase in coverage is obtained by increasing the aerial height than by doubling the ERP of the transmitter. It is therefore most desirable to choose a high site but before it is decided to use the top of the nearest mountain, it should be remembered that capital expenditure often rises as steeply as the rise in elevation. The building of approach roads, construction of large fuel tanks, installation of diesel powered generators and other auxiliary equipment on a difficult site can prove so costly that it forbids the use of a site that would otherwise be very at-

We refer readers to page 18 of April issue where the AWA contract for the construction of the transmitters was discussed. Illustrated at left is the control console with vision and sound transmitters in the background. Remote control panels for both transmitters and video processing controls are housed in the left-hand console while sound monitoring equipment is mounted to the right of the composite desk.





1. ESTIMATED TELEVISION COVERAGE FOR TRANSMITTER AT AUCKLAND.

   Aerial 270ft. above ground.
   Frequency 55 Mc/s.
   Receiving Aerial 30ft. above ground level.

2. ESTIMATED TELEVISION COVERAGE FOR TRANSMITTER AT MT. TE AROHA.

   Aerial 360ft. above ground.
   Frequency 45 Mc/s.
   Receiving Aerial 30ft. above ground level.

3. ESTIMATED TELEVISION COVERAGE FOR TRANSMITTER AT MT. WHARITE.

   Aerial 350ft. above ground.
   Frequency 62 Mc/s.
   Receiving Aerial 30ft. above ground level.

4. ESTIMATED TELEVISION COVERAGE FOR TRANSMITTER AT MT. SUGAR LOAF.

   Aerial 350ft. above ground.
   Frequency 62 Mc/s.
   Receiving Aerial 30ft. above ground level.

Omnidirectional______ Directional..............

A Grade — 68 db above 1 microvolt per metre. B Grade — 47 db above 1 microvolt per metre.

tractive. Climatic conditions may also be severe and in isolated locations this often creates a problem of transportation of both supplies and personnel. If climatic conditions are severe, ice formation on the aerial could cause trouble and because of the extra weight and wind the mast and aerial may have to be strengthened accordingly. On the other hand it should be borne in mind that remote control of modern transmitters on mountain top locations can be an economical procedure reducing personnel requirements.

Height of Aerial Support Structure

We now have to decide on the type of aerial supporting structure and its height. In many cases the height of the mast or tower is governed by the local regulations to reduce possible hazard to aircraft and approval for any plans should be obtained from the Civil Aviation Authority before they are finalised.

It is necessary to decide whether to use a guyed or stayed mast or a self supporting tower. The main frame of a guyed mast is comparatively light but the guy wires or stays take most of the stress. Such a mast requires much more ground space than the self supporting type and in rugged country or on sites close to large cities, this space may be limited. Guyed masts are usually cheaper than self supporting towers for heights greater than 250-300 feet. Where space is limited or where equipment such as microwave relay dishes are to be mounted on the aerial supporting structure, a self supporting tower is usually chosen.

Before deciding on the height of the aerial tower or mast it is advisable to compare the relative costs of transmitters and aerials on one hand and the aerial supporting structure on the other. To ensure maximum ERP a high gain aerial could be used but this would result in a heavy aerial and therefore a costly supporting structure. There is obviously a point where the cost of increasing the aerial gain and the tower height begins to compare most unfavourably with the cost of a larger transmitter.

Aerial

The gain of an aerial is achieved by stacking aerial elements one above the other and connecting them with suitable feeding arrangements. This stacking has the effect of concentrating the radiation in a horizontal direction. In special cases it is sometimes necessary to shape this radiation so that more coverage is produced in a highly populated area and this can be done with most aerials. Similarly, it is possible to tilt the main beam of the aerial so that it reaches the ground at the required point.

Transmitting Building

Before considering the equipment which is to be installed in the transmitter building, let us look at some of the problems which confront the architect who has to design this structure. We have seen that the selection of the transmitting site is directly related to the ideal conditions required for the location of the transmitting aerial. In many instances however, these requirements present the architect with the problem of building on marshland or in exposed conditions, and there are usually problems of access, provision of essential services, water, electric light and power and he usually has to design against severe climatic conditions.

Transmitters

When selecting a transmitter it is well to remember that such a purchase is a long term investment and selection should therefore be made with future requirements in mind. It is of paramount importance that the station should provide a reliable service. Although the most dependable equipment may be a little more expensive initially, this additional expense will be more than repaid by its quality of service and the small amount of maintenance expenditure incurred.

At this point the parallel operation of transmitters should be considered. This is a technique which was pioneered by the Marconi Company and which has become accepted throughout the world for the following reasons:

(a) The equipment is always in use.
(b) The transmission path is duplicated, hence there will be no break in programme under fault conditions.
(c) Because there is no break in programme faults do not have to be repaired under emergency conditions and therefore the problem of finding highly qualified personnel is much simplified.
(d) There is a saving in cost in that only one set of spare valves and components is required. This not only reduces the cost of the spares themselves but also of the building because the storage space required is not so great.
(e) The system is flexible in that the power of the station can be increased or decreased with the absolute minimum of interference with programmes.

New Zealand Stations

The New Zealand Broadcasting Corporation has planned high power television stations to serve the Auckland, Christchurch, Waikato and Manawatu areas. An order has been placed with Amalgamated Wireless (Australasia) N.Z. Limited for Marconi Transmitters and Aerials which have been designed specifically for New Zealand conditions. When these stations are commissioned a theoretical 75% of our population should be able to receive a good television picture.

Two 10kw Transmitters will be used at each site and they will operate in parallel to provide a combined output of 20 Kw's. These are established designs which are used in parallel in Australia, Canada, Sweden, Norway, Poland and the United Kingdom. They have been designed to transmit colour signals should the need ever arise and they are admirably suited for unattended operation and remote control—since their reliability has been proved beyond all doubt in the field.

Quadrant Aerials giving horizontal polarisation will be used at the Auckland site on the Waitakere ranges and also on Sugar Loaf near Christchurch. Stacked

please turn to page 39

V.H.F. MOBILE OPERATION

Continued from page 17

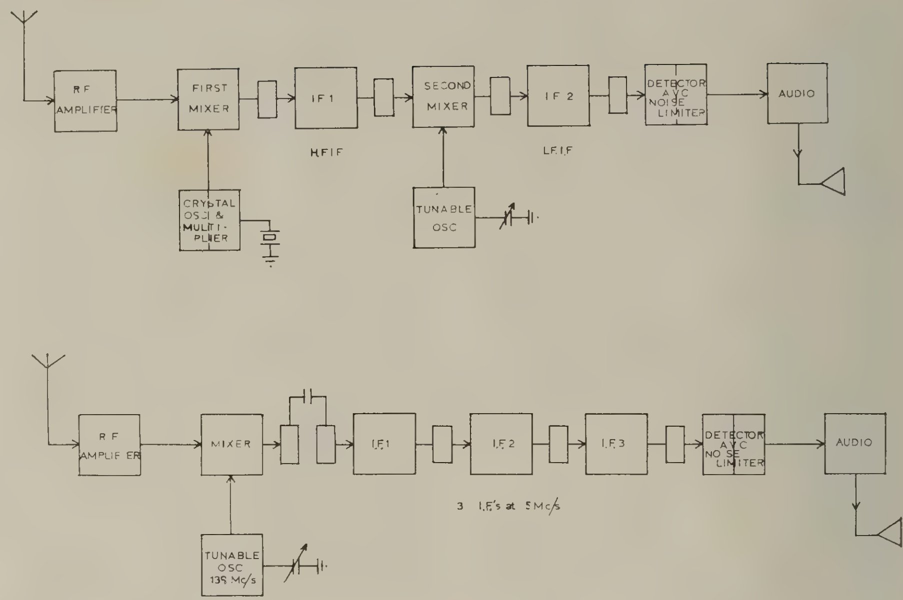


Fig. 1

receiver, the amount of noise which passes into the receiver and is heard accompanying the desired signal is directly related to the bandwidth of the receiver. The narrower the bandwidth, the less the total noise power heard by the receiver. In this statement there are, however, one or two opposing factors. The first of these is the fact that high peak level impulse noise such as auto ignition noise has the length of the pulse increased when it passes through a sharp I.F. chain, in addition to the fact that the sharp peaks of energy tend to shock the tuned circuits in the I.F. chain and cause them to "ring." Thus the noise pulse occupies more space in its ratio to signal heard, after being passed through a sharp, narrow band I.F. chain. Thus one of the simple series or shunt type noise limiters is less effective when used after a sharp I.F. chain than if it was used after a relatively broad bandwidth I.F. chain.

When a narrow band I.F. chain is employed, the problem of local oscillator stability and tuning range also rears its head.

If a receiver is being designed or built for 2 metre service, it is recommended that a tuning range of at least 144 to 145 mc/s be used, and preferably 144 to 146 mc/s should be considered. In the Auckland area at the present time there are stations operating all through the 1st megacycle of the band, many in close proximity to each other. Undoubtedly there will be some operating in the next megacycle up the band before long. If a tuning range of 1 to 2 megacycles is employed, then tuning and searching for stations when a sharp I.F. is employed, can be quite a problem, even when the station is a fixed station. When, however, the station is mobile, the problem can be much more acute. In addition any mechanical or electrical effects on the local oscillator circuitry can cause the required signal to be lost as it is moved out of the passband of the receiver, and constant retuning is required to maintain contact.

These foregoing remarks are the main reason why a receiver designed to cover say 400 to 500 k.c. of the 80 metre band and capable of receiving and selecting single sideband transmissions, for example, may not be the best type of receiver to use as a tunable I.F. section for a mobile receiving system.

It would appear, therefore, that the ideal type of receiver is one with the least number of heterodyning sections, a good sensitivity, and A.V.C. characteristic, an efficient noise limiter, a tuning rate of 1 megacycle or more, with a reasonable bandwidth available in the I.F. system to allow for non-critical tuning and easy location of weaker signals, and yet sufficient selectivity to reject adjacent channel signals if they appear. Coupled with this last requirement is an ultra-stable oscillator which will not move the desired stations out of the narrow passband if it is being employed.

With all these points in mind we have designed and tried several receiver systems which, whilst not described in intimate detail have been sufficiently well covered to enable our readers to build the equipment if desired. However, in most cases, this equipment may serve only as a guide for further work on the part of our readers.

The Simple Super Two Meter Receiver

This receiver is shown both in block diagram form in Fig. 1, and as a full circuit in Fig. 3. The equipment basically consists of a twin-triode cascode R.F. amplifier stage capable of reasonable performance, feeding a high gain yet quiet Pentode mixer, the triode section of this same tube acting as a tunable local oscillator 5 megacycles below the incoming signal frequency. The mixer feeds into a two-stage I.F. amplifier chain using 5 mc/s home wound transformers, thence into a diode detector, with a separate diode used for delayed A.V.C. The audio passes to a series diode noise limiter preceeding two stages of audio amplification giving sufficient power to operate a loudspeaker

in a car. The choice of tubes is such that the filaments of the 6 tubes can easily be series-parallel connected for either 6 or 12 volts. The 5 mc/s I.F. chain is chosen for reasonable image rejection, whilst good high "Q" coils can be hand wound, permitting reasonable selectivity and adequate gain with non-critical tubes and components.

With the cascode R.F. stage and the ECF86 pentode section as a mixer, the front end of the receiver exhibits good gain, together with a better than average noise figure.

If the reader desires more selectivity, then an extra transformer can be included between each tube (if there is space), coupled capacitively to the existing one in the circuit in a "back to back" arrangement.

To get some idea of the improvement using extra transformers, a slide rule was used and gave the following figures:

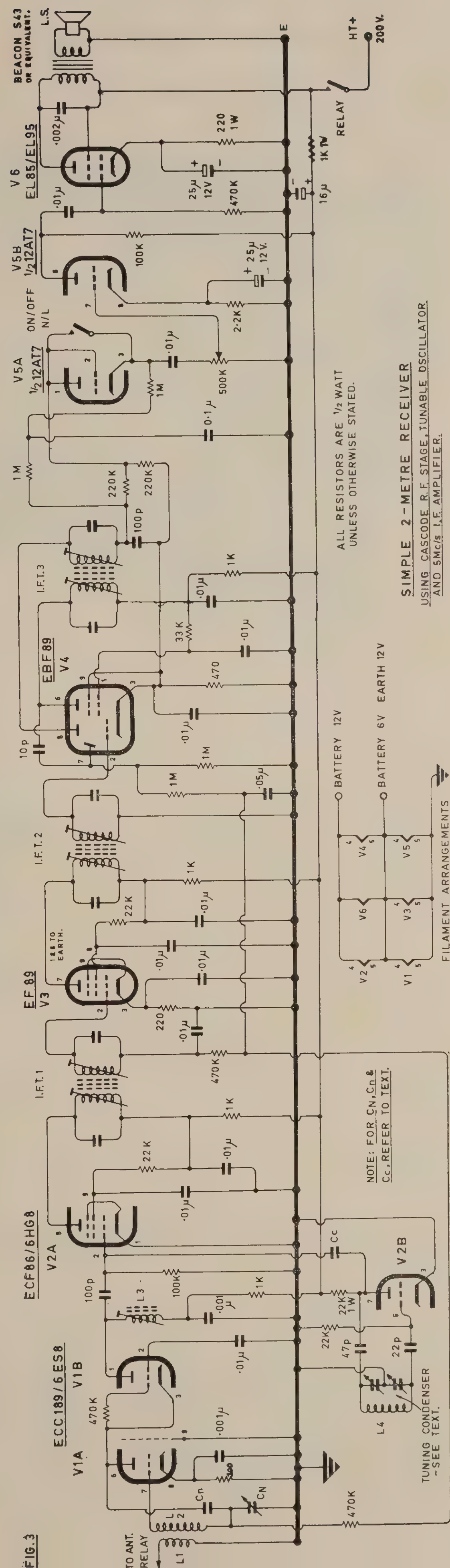
> The performance measured with 3 transformers was Bandwidth 3db. down ± 5kc., 40db. down ± 40kc.
>
> The calculated figures for 4 transformers were 3db. down ± 4.2kc., 40db. down ± 35kc.
>
> Similarly for 5 transformers the figures were 3db. down ± 4.0kc., 40db. down ± 30kc.

It is not recommended that more than 5 transformers be used in the chain as there will be insufficient gain available to overcome the losses in the transformers.

In Figure 4 we have shown diagrammatically the method of winding and assembling the I.F. transformers used in this chain. The windings are less than critically coupled to give the maximum selectivity. However it should be noted that the position of the tuning slugs will affect the coupling between windings and hence also affect the gain of the I.F. chain as a whole, as well as the selectivity. In all cases the windings should be resonated with the slugs on the outside region of each coil, i.e., at the

Fig. 3
Simple 2-meter Receiver

Using Cascode R.F. Stage, Tunable Oscillator and 5 mc/s R.F. Amplifier



Continued overleaf

top and bottom of the former, not in the centre region.

Details for the coils are as follows:

The antenna coil for the R.F. amplifier consists of 4 turns No. 18 gauge tinned copper wound on an O.B.A. slug tuned former. Winding spaced 1 wire diameter. The antenna link coil is 1½ turns of thin hookup wire at the bottom (earth) end of the coil.

The R.F. stage anode coil requires 3 turns similar to L1 except there is no link winding.

The Oscillator Coil. This should be wound on a ceramic former if possible, otherwise use a piece of polystyrene rod and secure the winding firmly with polystyrene coil cement. The winding consists of two turns, of 18 gauge tinned copper wire on ⅜in. diameter former, and occupying ⅜in. overall length. Use short, heavy leads to the oscillator tuning condenser which is a 9 pf. per section, two gang "Polar" type or equivalent. It is necessary to use a well constructed double ended condenser in this application and any dial which is used should not cause the condenser to bind or shift during tuning. If it is necessary to reduce the frequency coverage one or more plates can be removed from the rotor in both sections. A 3-30 pf. Philips trimmer is connected across the coil for band-setting purposes, and once adjusted this should also be secured with coil cement.

The coupling capacity between oscillator and mixer consists of two pieces of single strand hookup wire twisted together for a turn or so. Optimum adjustment of this capacity can be made when the receiver is operating.

The remainder of the receiver is quite simple. Readers are advised to follow the circuit for the filament connections, as it is necessary that certain of the filaments should be kept on the earth side of the series-string arrangement when 12 volts is being used.

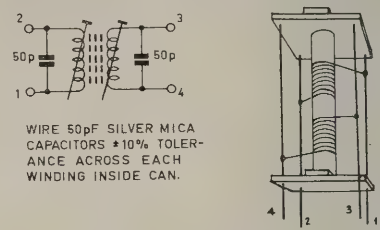
One other unusual feature is the use of one half of the 12 AT7 (ECC81), tied as a diode and used as the noise limiter. This was done because the tube types with triodes and separate diodes are not so readily available, added to which the 12 AT7 tied as a diode operates very well in this service.

In aligning the receiver, the constructor can do well to use a Grid-Dip Oscillator for aligning the R.F. coils and setting the oscillator tuning range. The I.F.'s, being in cans, cannot be checked in this way, but if a signal generator is not available for alignment, the connection of an antenna to the mixer grid at night time should produce W.W.V. on 5 mc/s, together with other commercial stations. However, the characteristics of the W.W.V. transmissions can be easily determined and allow the station to be located. Once this is done, all the I.F. transformers can be aligned for maximum signal, using a high resistance voltmeter or V.T.V.M. connected to the diode load. Final alignment on a received signal is all that is necessary, and the use of stations of known frequency, or harmonics of known crystals in the transmitter, will enable the dial to be calibrated. Don't forget to seal the slugs in the coils, on the first time the unit is used in a vehicle, or all the alignment will be disturbed due to vibration moving the slugs. This also introduces another point worth keeping in mind in connection with mobile equipment. All construction should be solid, with tie points liberally used for all loose wire, and ends and pigtails on all components, etc. Vibration will play havoc with the loose type of construction quite satisfactory for stationary equipment.

An Improved "Simple-Super"

For those who feel that the selectivity of the simple receiver described above is insufficient, we have shown in Fig. 2 a block diagram of a double conversion receiver. This is a little more expensive to build and requires a little more effort to get it going

FIG. 4. WINDING DETAILS OF I.F.T. 1 2&3



L1 & L2 SPACED 1½ CMS BETWEEN WINDINGS. EACH 35 TURNS OF ENAMEL COVERED WIRE NEOSID TYPE FORMER - O B.A. SLUG TUNED - COMPLETE WITH CANS AND IRON DUST SLUGS.

correctly. However, it does not use any more tubes than the "Simple-Super," but does have definite improved selectivity characteristics.

Basically, this receiver has a similar R.F. and mixer section to the "Simple-Super"; but the oscillator uses a crystal for control of its frequency, in a circuit, which will enable the one tube section to provide the correct injection frequency. The signal passes from the first mixer to the second mixer via a broad band, double-wound transformer. The second mixer, a triode-hexode tube, also has the self-contained oscillator triode operating as a tunable second conversion oscillator complete with tuning condenser, coil and dial. This second mixer converts the first I.F. frequency signal down to a fixed frequency of 455 kc/s, where a single stage of amplification with two I.F. transformers gives adequate selectivity and gain, providing that a tube with a reasonable gain figure is used in this stage. From the detector onwards the receiver again reverts to the same design as the "Simple-Super."

This concludes this month's discussion on receivers. Next month we will publish final data and circuits on the second type of receiver described above, and details of a fully transistorised 2 metre receiver using as a front end section the transistorised converter described earlier in this series.

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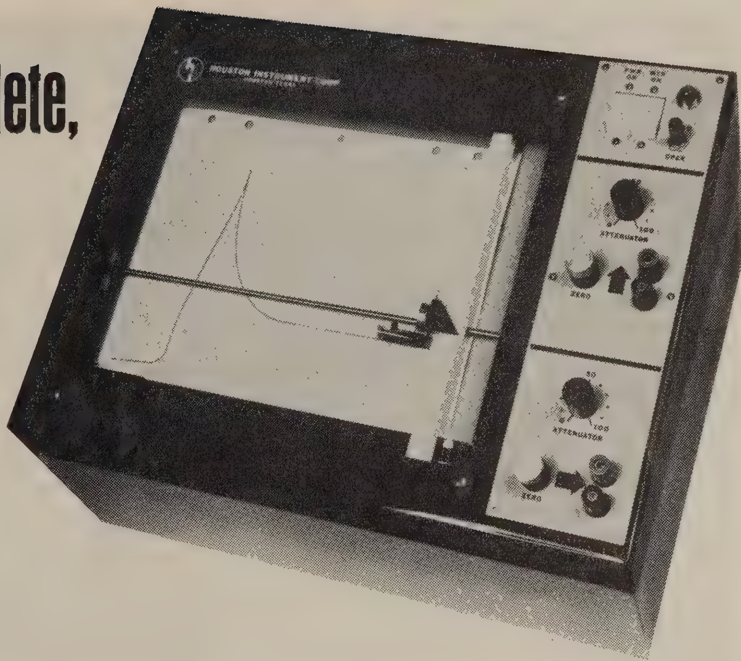

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Zener reference supplied
Electric pen lift
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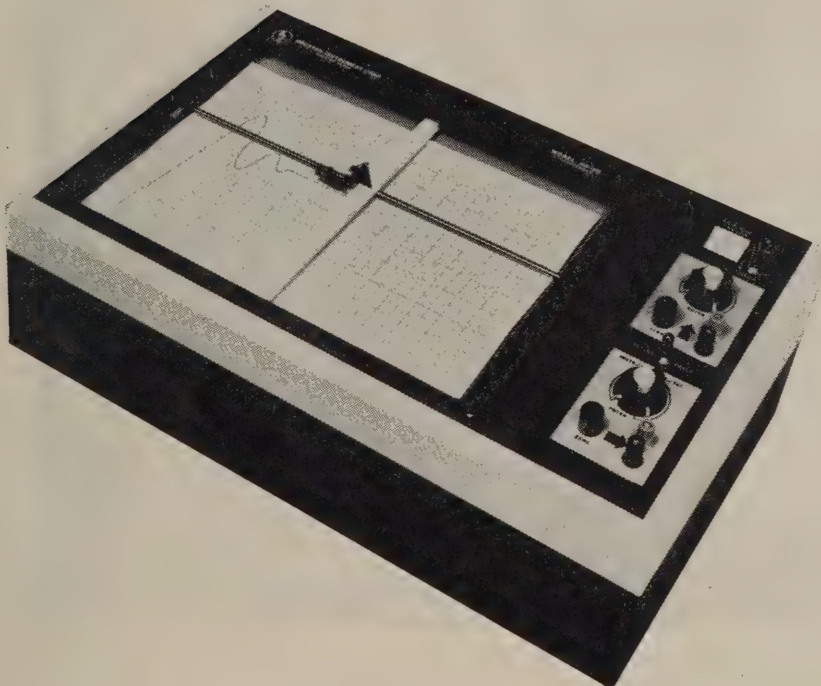
7½in/sec. pen speed
10 mv/in sensitivity



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Built-in electronic time base
Electric pen lift
Zener reference supplied
Switch selectable attenuators with vernier control between ranges
Snap-on assembly
10in/sec. pen speed
1 mv/in. sensitivity

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New! RCA-6146A, a Beam Power Tube with "Dark Heater", joins the outstanding RCA-6146 family. With RCA-6146A in the circuit, you can be sure that drop in power output will be negligible—even when the heater voltage is reduced to 5 volts!

When you replace with RCA-6146A "Dark Heater", you get the latest in electron tube technology: lower internal stresses for longer heater life; cooler operation to reduce possible heater damage; and stable heater-current characteristics.

This small, sturdily-built tube provides the same high efficiency and power output capabilities as its prototypes—35 watts CW (ICAS) at 175 Mc.; 70 watts CW (ICAS) at 60 Mc. RCA-6146A, as well as the entire 6146 family, is available through AWA.

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All feature the Dark Heater except 4604.

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	RF Amplifier & Osc. Service	RCA-6146A
	Pulse Modulator Service	RCA-6293
	Ruggedized; RF Amplifier & Osc. Service	RCA-6146W/7212
12.6-V	RF Amplifier & Osc. Service	RCA-6883
13.5-V	RF Amplifier & Osc. Service	RCA-8032
26.5-V	RF Amplifier & Osc. Service	RCA-6159
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VR23

An Unusual Electrostatically Focused Cathode Ray Tube

by K. E. GROVES, B.Sc. (Hons.)

Research staff at the Ferranti cathode ray tube laboratories in England have produced an unusual, electrostatically focused cathode-ray tube that achieves a resolution of 150 cycles/centimetre spatial frequency response, is four pounds lighter than the conventional type, and simplifies both the complexity and power requirement of the associated circuitry.

There are high-resolution cathode-ray tubes capable of achieving a resolution in excess of 400 cycles/centimetre spatial frequency response at 60 per cent. modulation, which is equivalent to 0.003 inch spot size. 130 cycles/centimetre spatial frequency response is equivalent to 0.001 inch and 260 cycles/centimetre is equivalent to 0.0005 inch.

Although this extremely high resolution is of use in special instances most practical applications require a resolution no greater than about 130 cycles/centimetre spatial frequency response.

Since there is no longer an immediate interest in obtaining higher resolutions, the staff at the Ferranti laboratories concentrated their attention on the design of a light-weight high-resolution tube capable of economical operation in conjunction with semi-conductor equipment.

For Airborne Radar Systems

The tube that has been developed is an important feature in certain types of transistorised airborne radar systems, for which the requirements are low weight, small size, and adequate performance.

Until the recent investigations by the Ferranti laboratory it was considered that electrostatic lenses were unsuitable for use in high-resolution cathode-ray tubes owing to the aberrations they introduce. For this reason, electromagnetic lenses have been used for high-resolution applications.

For obtaining a high resolution the electro-magnetic lens has the following advantages:

(1) The coil assembly is external to the cathode-ray tube and may therefore be easily adjusted.
(2) Size limitations are not governed by the glass envelope, and spherical aberration can be minimised by increasing length and diameter.
(3) Electromagnetic lenses can be designed to have low spherical aberration, and means for correcting coma and astigmatism aberrations can be easily incorporated.

Drawbacks of the electromagnetic focusing system are as follows:

(1) The coils are heavy, and require a power supply of approximately 15 volts at 400 milliamperes.
(2) The current in the coils must be stabilised to within ± 0.1 per cent. if optimum focus is to be maintained without adjustment.

These drawbacks mean that the power supply and e.h.t. (extra high tension) circuits of the associated equipment are bulky and costly, especially the e.h.t. circuits, where it has proved extremely difficult to achieve ± 0.1 per cent. stability.

Comparison of Lenses

There are two types of electrostatic lenses that can be used for high resolution cathode ray tubes: the acceleration lens, and the zero focus or Einzel lens (Figure 2).

The acceleration type of lens, which is used in the United States of America, has a number of disadvantages, the most important of which is the relatively low resolution obtainable — about 0.002 inch (0.050 millimetre). Another disadvantage of the acceleration lens is that it requires a high voltage capable of being varied, in order to adjust the focus of the electron beam.

The zero focus, or Einzel, lens introduces severe aberrations, and has not therefore been used for high-resolution applications until the recent further development of this type of lens. The

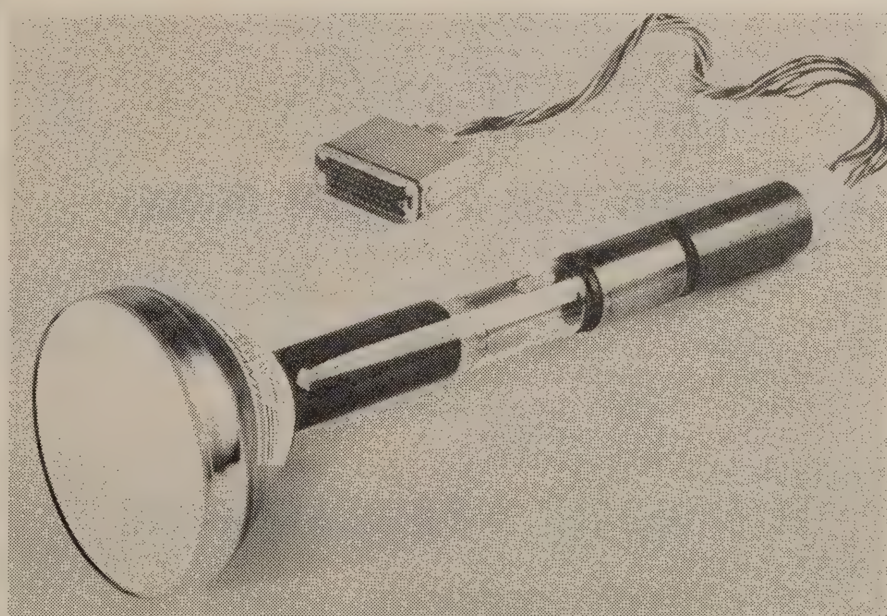

Figure 1. The new electrostatically focused, high-resolution cathoded-ray tube, developed at the Ferranti Cathode Ray Tube Laboratories, Gem Mill, Oldham, Lancashire, England.

Einzel lens does, however, possess one useful and important characteristic; a spot focused by it will maintain its focus despite variations of final anode potential of up to plus or minus 1 per cent. or even plus or minus 2 per cent. This particular feature indicated the possibility of reducing a substantial amount of the e.h.t. circuitry in addition to the reduced power requirement (owing to the absence of the large electromagnetic focus coil). Research and development was therefore concentrated on reducing and eliminating the aberration drawbacks.

In the first instance, spherical aberration was reduced by a new design of Einzel lens to a level approximately equivalent to that obtained in the standard type of electromagnetic lens. This new lens creates a larger diameter than is possible with a typical conventional type of construction. The three types of lenses are compared in the diagram given in Figure 2. The new electrostatic lens was designed by Mr. J. V. Shaw, of Ferranti Ltd., and is covered by British Patent 929849.

Figure 2. Comparison of electrostatic lenses suitable for high-resolution tubes: 1. Cathode; 2. Control grid; 3. First anode (5 kilovolts typical): 4. Limiting aperture; 5. Final anode (15 kilovolts typical); 6. ACCELERATION TYPE; 7. Cathode; 8. Control grid; 9. Limiting aperture; 10. First anode (15 kilovolts typical); 11. Second anode zero voltage electrostatic; 12. Third anode (15 kilovolts typical); 13. ZERO VOLTAGE OR EINZEL TYPE; 14. Cathode; 15. Control grid; 16. Limiting aperture; 17. First anode (15 kilovolts typical); 18. Second anode zero voltage electrostatic; 19. Third anode (15 kilovolts typical); 20. NEW FERRANTI ZERO VOLTAGE TYPE.

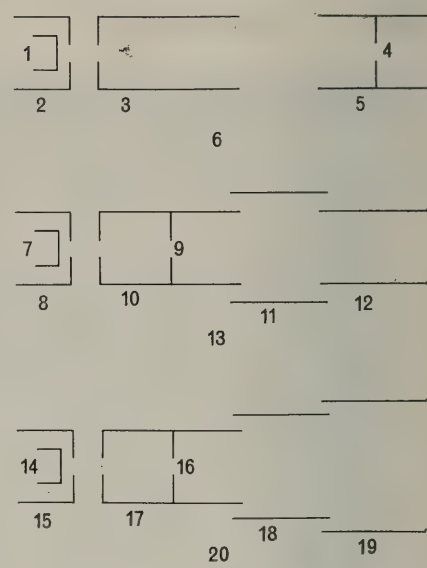

Fig.2

Unique Beam Alignment

Coma is caused by misalignment between the electron beam and the axis of the electron lens; the aberration can therefore be corrected by moving the beam so that the two axes are coincident. The latest method of moving the electron beam is by means of alignment coils mounted externally to the tube. The current type of electromagnetic focus coil incorporates this type of device and the idea has been "borrowed" for use with the new tube. The application of this method of beam alignment to electrostatically focused tubes is thought to be unique, and in the present design the alignment coil is located near to the cathode so that only small deflections of the beam are required to obtain coincidence. This positioning feature means that negligible distortions are introduced, and the power requirement for the coil is the extremely low

maximum of 30 milliamperes at ± 2 volts. The electrostatic lens is manufactured in such a way that the electrical axis and the physical axis are coincident and the anode limiting aperture can also be placed on these axes. Hence, it is possible to use the alignment coils, placed adjacent to the cathode, not only to find the centre of the lens, but to find the centre of the aperture.

Astigmatism is caused by misalignment and ovality in the separate components of the lens, and in some instances it can be extremely severe. Sturdy construction of the new lens has minimised astigmatism, but it has been necessary to adopt the philosophy of correction rather than elimination, and to this end a pair of di-quadruple astigmatism correction coils have been employed. This feature, which is also thought to be unique, has been borrowed from the latest electromagnetic focus coil techniques: the location of the coils are shown in Figure 4. Astigmatism can be produced by these di-quadruple coils, and hence, if the astigmatism that they produce is so arranged that it is equally opposite to the astigmatism in the tube, the net result is a complete absence of astigmatism.

Both the alignment and astigmatism-correction coils are so arranged that they can produce alignment and astigmatism correction in any direction in the X, Y plane (the Z direction is normally the axis of the tube). Total maximum power requirements for the astigmatism and the alignment coils is ± 2 volts at 60 milliamperes total.

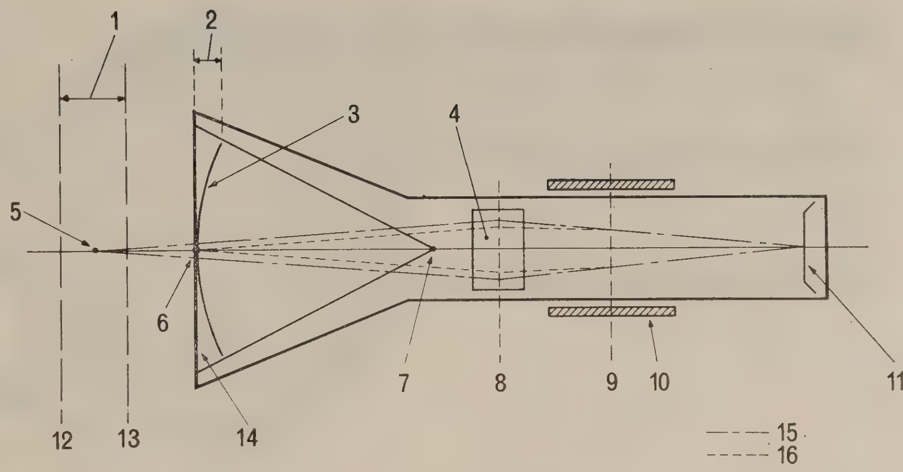

Fig.3

Figure 3. Electrostatic and electromagnetic ally focused cathode-ray tube, showing the effect of focus tolerance, magnetic trimming and dynamic focus requirements.. 1. Electrostatic lens focus tolerance—equivalent to plus or minus 300 volts. 2. Represents maximum dynamic focus distance. 3. Electrostatic and electromagnetic lens focus without dynamic correction. 4. Electrostatic lens. 5. Possible point of electrostatic focus. 6. Correct focus. 7. Centre of deflection. 8. Lens centre. 9. Lens centre. 10. Focus trimming lens. 11. Cathode. 12. Maximum. 13. Minimum. 14. Screen. 15. Beam envelope for electrostatic focus plus magnetic trimming.

Practical Difficulty

It is difficult and uneconomic to produce an electrostatic lens that has an exact specified focal length, because the spread of manufacturing tolerances would cause the actual point of focus to occur between two points along the Z axis (Figure 3). Another way of stating this is that if the focus is to be achieved on the face of the cathode-ray tube, the potential of the focus electrode must be variable between specified limits in order to ensure that focus can be achieved on all the tubes from the production line. These limits are of the order of plus or minus 300 volts about the target potential (the target potential is usually zero volts); it is not convenient to provide such a variation in voltage if the ancillary equipment is transistorised. In order to overcome this shortcoming, the following new arrangement has been adopted.

The electrostatic lens is used as the main lens, and the structure of the lens is so arranged that when the focus voltage is at zero potential, the minimum electron-beam focus point lies just beyond the cathode-ray-tube screen (Fig. 3). In other words, the tube, under these conditions, does not quite display the optimum focus. A small low-power electromagnetic lens is employed in order to trim the focus so that the optimum focus is achieved (Figure 3). The advantage of this system is that the maximum power supplies are 20 volts at 60 milliamperes, instead of the plus or minus 300 volts variation that would otherwise be required. Another advantage is that the electrostatic lens is connected to zero potential and, therefore, does not consume power. Average power requirement for the focus trimming coil is 10 volts at 30 milliamperes.

The new tubes are flat faced, so it may be necessary to correct

please turn to page 37

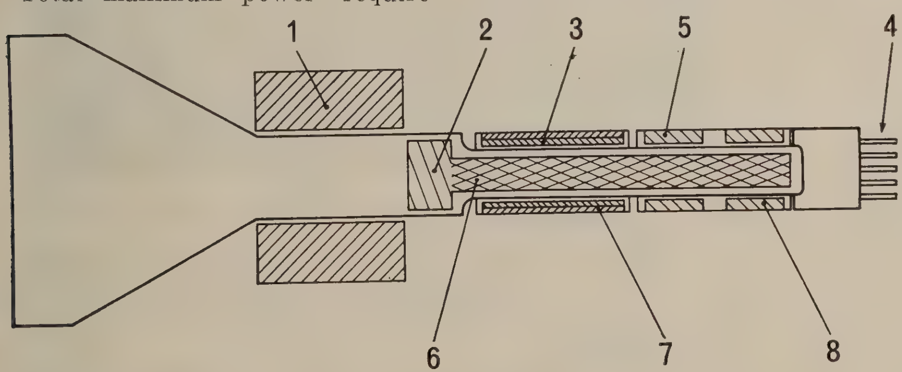

Fig.4

Figure 4. Layout of the new Ferranti cathode-ray tube, which combines zero-voltage electrostatic and low-power magnetic focusing. 1. Deflection coil. 2. Electrostatic lens. 3. Dynamic focus coil. 4. Tube and coil connections. 5. Astigmatism coil. 6. Electron gun. Focus trimming coil. 8. Alignment coil.

NEW PRODUCTS: LATEST RELEASES IN ELECTRICAL AND ELECTRONIC EQUIPMENT

This section of our paper is reserved for the introduction of new products and space preference is given to our regular advertisers. For further particulars, contact Advertising Manager, "R. & E.," Box 1365, Auckland.

LOW COST PARAMETRIC AMPLIFIER

A low-cost parametric amplifier for use on VHF and UHF bands has been developed by Britain's Production Engineering Research Association. Parametric amplifiers are used in television link networks and in satellite communications to amplify weak signals. As they add very little noise to the signal they enable even extremely weak signals from distant transmitters to be heard without difficulty.

HIGH SPEED DIGITAL COUNTER

A completely transistorised digital counter, capable of direct counting at 100 Mc/s without the aid of any auxiliary equipment, is being produced by a British firm. It accepts pulse or sinewave inputs in the frequency range d.c. to 100 Mc/s and is claimed to maintain an input sensitivity of better than 100 millivolts from 100 c/s to 100 Mc/s.

NEW SOLARTRON CONSTANT VOLTAGE/CONSTANT CURRENT POWER SUPPLY, TYPE AS 1218

The new Constant Voltage and Constant Current Power Supply, type AS 1218, particularly suited for application involving inductance, is the latest in the long line of accurately stabilised power supplies developed and manufactured by the Solartron Electronic Group, Ltd., Farnborough, Hampshire. It is fully transistorised.

By the touch of a switch, a supply of constant voltage or constant current is immediately available at the bench. The voltage and current outputs are set by continuously variable decade switches and a fine control. The instrument has a remote voltage sensing facility which eliminates connecting lead impedances by including them within the feedback loop.

The constant voltage output range is from zero to 30 volts and the current from zero to 10 amperes. A high grade meter is incorporated.

The instrument is short circuit/open circuit proof with visual "out of limit" indication.

Output is isolated from chassis with an insulation that will permit the AS 1218 to operate with output terminals at 250 volts relative to earth. It will operate unrestricted at temperatures up to 45°C. ambient, above which the output is derated linearly to zero output at 70°C. The temperature co-efficient is $\pm 0{\cdot}5\%$. The long-term stability in constant ambient temperature and with constant input and output conditions is $0{\cdot}05\%$.

The thermal overload protection safeguards against over-heating caused by accidental air blockage or excessive ambient temperature. It has forced air ventilation. The instrument is inherently proof against short circuit/open circuit conditions at the output terminals also.

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RANK CINTEL TO PRODUCE CORSAIR COMPUTER

A contract has been awarded to Rank Cintel, a division of The Rank Organisation, by the British Ministry of Aviation for the production of the Corsair digital differential analyser (d.d.a.), the original design of which came from R.A.E., Farnborough.

Corsair is an all transistor transportable d.d.a., designed for the rapid and accurate solution of all forms of differential and other equations and combines the advantages of the digital and analogue types of computer. The individual intergrators are identical and may be programmed as in an analogue computer; within each integrator however, the computation is performed digitally. Interconnection of these units is via a patch panel on the front of the instrument.

Corsair thus retains the accuracy and some of the flexibility of the general purpose digital computer while having, because of its special organisation, the directness of application of the analogue machine.

(Please turn to page 40)

for deflection defocusing. This correction can be achieved by applying, through a dynamic focus coil, a dynamic wave-form which is synchronised with the rate of scan. The dynamic focus coil is located inside the electromagnetic trimming coil.

The alignment and the astigmatism coils form one assembly, and the trimming coil and dynamic focus coil form another assembly (Figure 4). The outside diameter of the two coil assemblies is so designed that a standard deflection coil yoke can be passed over them. This design feature saves the user the task of positioning the trimming, astigmatism and alignment coil assemblies when the tube is fitted to the equipment. The trimming coil and the astigmatism and alignment coil assemblies are fitted to the tube at the factory and, after careful alignment, are potted in position.

Fibre Optic Tube

The latest Ferranti development involving this type of structure and coil arrangement is a tube that has a fibre optics face plate. The new lens technique is ideal for miniaturisation, and the new fibre optics tube that is under development indicates that a reduction of size and weight by a factor of one-third can be achieved when compared with the tube that is the subject of this article. This new fibre optic tube will be another important step towards high-resolution cathode-ray tubes of light-weight, compact design and high-quality performance.

An Unusual Cathode Ray Tube

Continued from page 35

The Future In Electronics

Continued from page 9

as the mainstay of any engineering organisation, and he could see a difference betweeen electronics and other trades. In most trades once a man had finished his apprenticeship and qualified, he might not have much need to open a book again, but it appeared that in electronics one never finished training. There might be a need for an appropriate examination, he thought. Bachelors of Engineering could register as professional engineers, but this was not open to B.Sc. graduates, and the Board is open to suggestions as to how to meet the need for such graduates to achieve registration.

Mr. E. C. McLauchlan, President of the Electronics Institute, discussed the function of the Institute in the future. "The effectiveness of any organisation depends wholly on the calibre of its members," he said, and that the Institute must extend its interests beyond Engineering Associates although they would probably form a higher percentage of membership in the future. The Institute should aim at attaining a seat on the Engineering Associates Registration Board, which would be achieved by the number of members registered as Associates, so as to make a worthwhile contribution to the Board.

Being so far from many factories, Mr. McLauchlan said, created a need for local design, because of the difficulty in servicing imported equipment under local conditions. Examinations were needed to meet local needs rather than following overseas qualifications. The need for an Institute post-graduate qualification is under consideration. He stressed the need for a closer relationship among engineers in research, development and industry. The Institute has a place in electronics as a means of these people getting together for a free interchange of ideas. Industry can help, through Industrial Associate Membership, and in so doing can help itself.

Referring to miniaturisation of equipment, Mr. McLauchlan suggested that the trend is for the scientist or physicist to oust the engineer in electronics from the spearpoint of development.

During the general discussion following the formal speeches, a member criticised conditions in New Zealand, that young men in unskilled trades can earn as much as a technician who has spent a lifetime in electronics, and gave examples of the low rewards to highly trained men who had contributed considerably to New Zealand economy. In reply, Mr. Carver stated that New Zealand does not realise how greatly it depends on electronics already, and will soon wake up to a grave shortage of trained men.

Other members referred to the growing importance of the physicist compared with the engineer, and the need for economics as a subject in training. More training, during working time, was considered by some to be essential to contribute to a higher standard in training.

"We have had a little bit of the picture of the future," said Mr. W. S. Strong, chairman of the symposium, in summarising. "We have seen something of what we need to do in the future."

Professor C. A. Peddie, in thanking the speakers, remarked that it had been a most useful discussion, although the problem had not been solved, only that we had been presented with it. All agreed that there is a future in electronics, but in training one could not afford to be a prophet. Electronics had made such strides in his lifetime that he fully agreed with the need for flexibility and versatility in training. The New Zealand Certificate of Engineering, he considered, provided an incentive for the "middle group."

Book Reviews . . .

"Propagation of Radio Waves at Frequencies Below 300 kc/s."
Edited by W. T. Blackband
Published by Pergamon Press

The title of this book is misleading, in that it is unfortunately not a treatise or text on terrestial propagation of VLF signals. It is a full report of all the papers presented at the seventh meeting of the Advisory Group for Aeronautical Research and Development, NATO, Ionosphere Research Committee, Munich 1962. With the rapid development of research in the VLF region there is urgent need for some text which will collate the considerable volume of information which has been published during the last decade or so, sift the straw from the chaff and present the findings in a condensed but authoritative form. Apparently this has still to come.

All the papers are presented by experts in their own field and most are limited in scope. Two of the papers are in French as is the opening address by the Deputy Chairman, Prof. Vassy. A total of 31 papers are included roughly classified into the following groups: (a) The Lower Ionosphere· (b) D Layer Irregularities. (c) The Lower Ionosphere and Low Frequency Propagation. (d) Oblique Incidence Measurements. (e) Radio Noise below 300 k/c. (f) Very Low Frequency Propagation. (g) Extremely Low Frequency Propagation. (h) Earth Resonance.

Several of the papers were in the form of a review and those that the writer most enjoyed (probably because he understood what the speakers were talking about) were the papers by J. R. Watt and by the New Zealander D. D. Crombie (et. al.). Others interesting papers covered a commentary on the "LOFTI" satellite reception of VLF signals which demonstrated that transmissions in these frequency ranges could penetrate the ionosphere, and a brief further report on the effect of the Johnson Island high altitude bomb test of July 9th, 1962, with reference to the effects on the received phase of four of the VLF stations. As none of the transmission paths of these stations passed near the test site the results were not as dramatic as reported by other observers.

This book will appeal only to a limited public, however, to those interested in VLF propogation and "Whistlers" it is essential reading. Those studying the structure of the ionosphere will also find it extremely valuable, particularly as it deals with the lower, or D layers which are not so amenable to investigation by classical HF and VHF methods.

—L.S.S.

The second book this month is entitled **"Low Noise Amplifier Design."** Produced as part of the G.E.C. valve and Semiconductor Publicity Service for the M.O. Valve Company Ltd., London, this 80 page publication is likely to be one of the most useful texts for the practical and design engineer working with R.F. receiving equipment in the V.H.F. and U.H.F. region of the Radio Spectrum. Whilst continual reference is made to the company's range of low noise vacuum tubes, the text deals in a concise and useful manner with the problems of noise inherent in R.F. amplifiers, methods of improving signal to noise ratios and noise figures and shows the various ways in which these variables can be controlled. Practical circuits with component values and actual measurements are given, together with details of the equipment required and designed to carry out these measurements. There is a full page of references and many useful graphs and curves.

Our copy came direct from the New Zealand Representatives of the M.O. Valve Co., Messrs. British General Electric, to whom bona fide enquiries re this book should be made.

Planning a Television Transmitter

Continued from page 27

dipole rays broadcasting vertically polarised signals will be used at the Waikato site—Mt. Te Aroha, and at Wharite near Palmerston North to serve Manawatu. All four aerials are constructed in two halves with each half designed to be fed by a separate independent transmission line. Each aerial has a shaped polar diagram adapted to suit local conditions and in each case the main beam will be tilted 0.8 degrees below the horizontal. The gain of approximately five times will boost the transmitter power to give an E.R.P. at each site of 100 Kw. Self supporting towers approximately 400 feet high are used and provision has been made on these for the addition of a second aerial to accommodate any alternative programme which may be offered in the future.

The Transmitter buildings for Christchurch and Te Aroha have been designed by the New Zealand Ministry of Works, while those for Auckland and Wharite are the responsibility of a private group of architects.

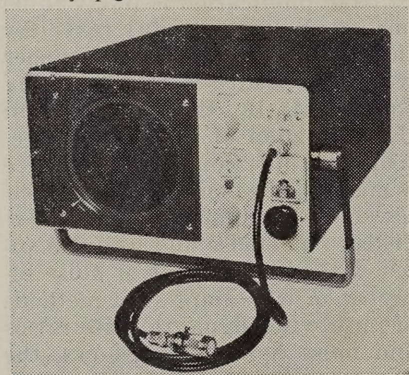
Throughout their planning the New Zealand Broadcasting Corporation have maintained a team of engineers to predict the coverage to be obtained from these sites and to check the theoretical results in the field. In this article we have shown theoretical coverage diagrams which have been prepared by Amalgamated Wireless.

The interim television stations at Auckland, Wellington, Christchurch and Dunedin have been operating successfully for some considerable time and New Zealand viewers have come to expect a technical quality second to none. When 100 Kw. stations are commissioned the history of reliability and high quality which has been established will be continued and within the resources of our country the greatest number of people should be able to receive a television programme within the shortest possible time.

NEW PRODUCTS—Continued

A number of ancilliary equipments are also included in the development contract to constitute a complete installation. Examples of these are; analogue to digital converter for analogue inputs; digital to analogue converter for plotter/recorder and a decimal to binary converter.

The new DAWE vetrasonic equipment illustrated is the 1803 Animal Sonoray designed to give quick and accurate measurements of fat thickness on both live and dead animals, particularly pigs.



Careful design allows the use by an unskilled operator and the small transducer of ½in. diameter and cheap coupling fluid makes for easy operation. Battery operation allows use in any location and the mains can be used for recharging the internal battery.

Pulse echo circuits are used and the display is read on a cathode ray tube so the operation is entirely harmless and safe. The usual scale calibration is 0-90 mm. of pig fat and 0-72 mm. of carcase fat.

The unit is fully portable, weighing only 26lbs., and is fully protected against the weather and farmyard conditions.

B.E.A. SELECTS NEW RECORDER

A new magnetic wire recorder for aircraft, designed for the retrieval of recorded data under the worst conceiveable conditions, has been selected by British European Airways for all its fleet. It consists of a quick-release cassette, containing the wire and three heads for erase, write and read, and a drive unit. One loading of wire gives 200 hours recording time.

Ceramic as Strong as Steel: Hard as Sapphire

A new ceramic as strong as steel and as hard as sapphire (bettered only by diamond) is being produced by a British firm. Only one quarter the weight of steel, it can be cut, drilled and screw-threaded by a normal metal-working techniques. It is called Roydazide and is made by a process developed by the Department of Scientific and Industrial Research to meet a vital need of the aircraft industry.

Telephone Dial Lock Prevents Unauthorised Calls

Telephones fitted with "dial locks" to prevent unauthorised use of the instrument are being produced by a British firm. The device has been designed for subscribers who wish to prevent telephones from being used for outgoing calls during their absence, but leave them capable of receiving incoming calls. It can also be used by industrial, commercial and business organisations who want to stop private calls being made over company telephones.

Pocket-Size Paging Radio with 30-Mile Range

A pocket-size radio receiver for paging personnel at distances up to 30 miles from the transmitter has been developed. It can be set to emit a single transmitted tone, representing some simple pre-arranged message such as "return to base," or to receive a verbal message.

New Uses for Inverters

For a new operating technique carried out at a London hospital an inverter was an important part of special medical equipment. The equipment had to be in continuous use nine hours prior to, and during an operation on a patient. This called for an a.c. power supply close to the patient at all times, including movement of the patient from ward to operating theatre.

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